

**PHASE I
REMEDIAL INVESTIGATION
SAMPLING AND ANALYSIS PLAN, REVISION 1
FOR THE
LUSHER STREET GROUNDWATER
CONTAMINATION SITE
ELKHART, ELKHART COUNTY, INDIANA**

Prepared for
**UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION V**

Prepared by
WESTON SOLUTIONS, INC.
Superfund Technical Assessment and Response Team

January 13, 2009

Approved by:

Date: _____

U.S. EPA Region V
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ACRONYMS AND ABBREVIATIONS

%	percent
µg/kg	micrograms per kilogram
µg/L	micrograms per liter
EC	Degrees Celsius
ASTM	American Society for Testing and Materials
bgs	below ground surface
CLP	Contract Laboratory Program
COC	Chain-of-Custody
IDW	Investigation-derived Waste
MCL	Maximum Contaminant Limit
NTU	Nephelometric Turbidity Unit
PCE	Tetrachloroethylene
PID	Photo-ionization Detector
PPE	Personal Protective Equipment
QAPP	Quality Assurance Project Plan
QA/QC	Quality Assurance/Quality Control
ROW	Right-of-way
RPM	Remedial Project Manager
SAP	Sampling and Analysis Plan
SOP	Standard Operating Procedure
START	Superfund Technical Assessment and Response Team
s.u.	standard units
TCA	1,1,1-Trichloroethane
TCE	Trichloroethylene
U.S. EPA	United States Environmental Protection Agency
USCS	United Soil Classification System
VOA	Volatile Organic Analysis
VOC	Volatile Organic Compound
WESTON	Weston Solutions, Inc.

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1.0 Introduction

This Sampling and Analysis Plan (SAP) identifies the data collection activities and associated quality assurance/quality control (QA/QC) measures specific to the Lusher Street Groundwater Contamination Site (Site) located in Elkhart, Elkhart County, Indiana. All data will be generated in accordance with the quality requirements described in the *START Site Specific Quality Assurance Project Plan (QAPP)*. The purpose of this SAP is to describe site-specific tasks that will be performed to determine which facilities within the area of the Site are contributing contaminants to the groundwater plume. The SAP will reference the site-specific QAPP for “generic” tasks common to all data collection activities, including routine procedures for sampling and analysis; documentation; equipment decontamination; sample handling; and data management, assessment, and review. Additional site-specific procedures and/or modifications to procedures described in the *START Site Specific QAPP* are described in the following SAP elements.

The data will be used to determine which facilities within the area of the Lusher Street Ground Water Contamination Site are contributing to the groundwater contamination plume.

This SAP was prepared, reviewed, and approved in accordance with the procedures detailed in the *START Site Specific QAPP*. Any deviations or modifications to the approved SAP will be documented using the **SAP Table 1 SAP Revision Form**.

2.0 Project Management and SAP Distribution

Management of Site activities will be executed in substantial conformance with the *START Site Specific QAPP*. The *START Site Specific QAPP* contains the organizational chart, communication pathways, personnel responsibilities and qualifications, and special personnel training requirements.

The following personnel will be involved in planning and/or technical activities performed for this data collection activity. Each will receive a copy of the approved SAP. (A copy of the SAP will also be retained in the site file.)

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QA – Quality Assurance

RPM – Remedial Project Manager

START – Superfund Technical Assessment and Response Team

U.S. EPA – United States Environmental Protection Agency

3.0 Planning and Problem Definition

3.1 Problem Definition

The United States Environmental Protection Agency (U.S. EPA) identified 20 facilities for soil and groundwater sampling. These facilities are potential sources of chlorinated solvents (1,1,1-trichloroethane [TCA], tetrachloroethylene [PCE], and trichloroethylene [TCE]) previously detected in the groundwater. Additional facilities could be identified at a later time.

At the direction of the U.S. EPA, the Weston Solutions, Inc. (WESTON®) investigation of the Site will include soil and groundwater sampling and analysis at 16 facilities. The Site location is presented on Figure 1 and the sampling locations are illustrated on Figure 2. TCE contamination detected in wells is provided on Figure 3 and TCA and PCE concentrations detected in wells is provided on Figure 4.

3.2 Site History and Background Information¹

The Lusher Street Ground Water Contamination site consists of a ground water plume. The sources contributing to the ground water plume have not been identified. The plume consists primarily of chlorinated solvents, including: TCE, TCA, trans 1,2-dichloroethylene (trans 1,2-DCE), cis 1,2-dichloroethylene (cis 1,2-DCE), 1,1-DCE, and PCE. The current plume boundary was delineated using data from residential and commercial private wells. The outer boundaries of the contaminated ground water plume have tentatively been established from west to east along Lusher Street from Nappanee Street to Oakland Street and north to south from the St. Joseph River to Hively Avenue. The ground water plume boundary is presented on Figure 1 and is coincident with the extent of the Site. Non-detect wells were identified surrounding the plume. The plume was drawn by connecting a line along the perimeter of all contaminated wells on the outer edges of the sample area. Thirty-six wells, consisting of residential and commercial private wells, were found to be contaminated with chlorinated VOCs. These 36 wells are within a one-mile radius of the center of the plume. The center of the plume is denoted by the private well (at the Avalon Street location) with the highest concentration of VOCs in the drinking water.

In 2006, IDEM's Site Investigation Section began Site Inspection (SI) activities at the Lusher Street Ground Water Contamination Site. IDEM conducted five sampling events. The results from investigations showed that the concentrations of TCE were above the maximum contaminant limit (MCL) of 5.0 ug/L in 9 wells, and ranging from 7.4 to 640 ug/L. The water in one well was found to contain elevated levels of 1,1-DCE (16J ug/L). The MCL of 1,1-DCE is 7 ug/L. A total of 10 wells were found to exceed the MCL. Low concentrations of chlorinated VOCs (below MCLs) were detected in approximately twenty-four (24) wells. The highest concentration of trichloroethylene (TCE) was detected at 41°40'22.52" north latitude and 85° 59' 46.41 " west longitude

Although the source of the chlorinated solvents has not been identified, there are numerous facilities in the area. The Site was discovered during the investigation of the K.G. Gemeinhardt Company (Gemeinhardt) as discussed below. From the 1940s through 1977, Gemeinhardt and its predecessors, owned and operated manufacturing facilities on a three-acre site at 57882 State Route 19. In 1985, Gemeinhardt agreed to an interim remedial action, whereby Gemeinhardt shall conduct an investigation sufficient to fully characterize the sources and extent of ground water identified to the north-northwest of the facility. While conducting an extent of contamination study at Gemeinhardt under the terms of the 1985 Consent Order with the EPA, VOCs were detected in private drinking water wells in an area immediately south of Lusher Avenue. At the time of this investigation, Gemeinhardt believed that the contamination in this area was independent of the Gemeinhardt ground water plume. The Elkhart County Health Department (ECHD) was notified of the contamination. In 1987, ECHD began an investigation of the area. The investigation was limited to an area bordered by State Road 19 on the west, Avalon Street to the east, Lusher Street to the south, and the St. Joseph River to the north. The ECHD sampled 145 wells in this area. The ECHD identified 103 private drinking water wells found to contain elevated levels of TCE and TCA. Subsequently, ECHD requested assistance from EPA in providing alternate drinking water supplies to the affected residences and businesses.

In October 1987, the on-scene coordinator (OSC) of EPA, in conjunction with EPA's Technical Assistance Team (TAT), began an investigation into the ground water contamination. Analytical results collected by TAT on November 3, 1987 confirmed the presence of TCE and TCA as well as other volatile organic compounds found at concentrations exceeding the removal action levels of contaminated drinking water sites. Of greatest concern were the levels of TCA (1,590 ppb) at a location on W. Indiana and TCE (804 ppb) at a location on 17th Street. As a result of the investigation, EPA initiated a removal action at the Lusher Street Groundwater Contamination Site to mitigate the immediate threats to human health and the environment posed by the ground water contamination of residential and business water wells. EPA defined the Site as the Lusher Street Groundwater Contamination Site on January 12, 1988. It should be noted that Lusher Street is actually Lusher Avenue. All references to Lusher Street apply to Lusher Avenue throughout this SAP. The removal action consisted of EPA installing point of use carbon filters in 13 Elkhart residences and businesses to reduce contaminant concentrations below the acceptable safe drinking water standard for all contaminants involved. In addition, EPA converted the water supply in two residences from private well water to city water because these residences showed contaminant levels, which exceeded the contaminant actions levels for the Agency for Toxic Substances and Disease Registry (ATSDR) bathing concern levels. As directed by the U.S. EPA OSC, TAT conducted an extent of contamination study from January 18, 1988, to March 16, 1988, which included collecting a total of 45 residential and business well samples. From August 18, 1988, to August 31, 1988, based on the results of the extent of contamination study, five additional residences and businesses were connected to city water. This removal action, which consisted of investigation and provision of point of use carbon filters and connection to city water was completed on August 31, 1988.

Indiana Department of Environmental Management (IDEM) began their own water testing during the summer of 1989 to determine if other residents would be provided alternate water supplies at the

state's expense. Municipal water lines were extended to the majority of properties impacted, except at one residence, located on Avalon Street. Municipal water was not provided to the residence on Avalon Street because no municipal water main was in close proximity.

EPA identified Walerko Tool & Engineering Corporation (Walerko) liable for the ground water contamination around Lusher Street. Walerko commenced business operations in 1952. Walerko engages in machining, tool and die work at its manufacturing plant located at 1935 West Lusher Avenue in Elkhart, Indiana. Walerko used the cleaning solvent TCA as a parts cleaner in Walerko's manufacturing process. Periodically, when the tanks and smaller containers of solvent became dirty, Walerko employees disposed of the spent solvent outside of the facility onto the ground, and then refilled the containers with fresh solvent. In 1987, the drinking water well located at Walerko indicated the presence of TCA at a concentration of 660 parts per billion (ppb) and TCE at a concentration of 38 ppb. On September 24, 1993, EPA filed a Cost Recovery Consent Decree with Walerko Tool & Engineering Corporation. The consent decree filed a complaint pursuant to Sections 104(e) and 107 of the Comprehensive Environmental Response, Compensation, Liability Act of 1980, as amended ("CERCLA"), 42 U.S.C Sections 9604(e) and 9607, and Section 3007 of the Resource Conservation and Recovery Act ("RCRA"), 42 U.S.C. Section 6927. The United States was seeking reimbursement of response costs incurred by EPA and the Department of Justice for response actions in connection with the release or threatened release of hazardous substances, including TCA and TCE, at the Lusher Street Site in Elkhart, Indiana and civil penalties for Walerko's failure to timely respond to EPA's information requests dated March 26, 1990.

In 1987, the water at the same Avalon Street location mentioned above had TCA at 69 ug/L, TCE at 11 ug/L, TCA at 74 ug/L, DCA at 19 ug/L, and DCE at 14 ug/. From the 1980's to present IDEM has been conducting operation and maintenance (O&M) activities at that Avalon Street location. In 2005, the water at the Avalon Street location was sampled by IDEM staff to determine if operation and maintenance (O&M) activities still needed to be conducted. Sample results revealed that the TCE levels were now detected as high as 700 ug/L. Subsequent ground water sampling, as part of the Site Inspection activities conducted in 2006, revealed that numerous nearby private wells have also been impacted with elevated levels of volatile organic compounds, as described above.

After the results of the water from the wells sampled were reviewed and found to be unacceptable for use, IDEM's State Clean Up Program provided bottled water to those people whose water was found to exceed MCLs. IDEM alerted the U.S. EPA OSC that some residential sample results for TCE had exceeded or were close to the MCL. In August 2006, START sampled four residential and one business location to correlate IDEM's data results. U.S. EPA's Emergency Response OSC then provided some residents with point of use carbon filters.

In addition to the ground water contamination, U.S. EPA and IDEM are concerned about potential vapor intrusion into the residences of the area.

3.3 Description of Locations for Investigation

The following provides background information on the various properties to be investigated. The properties can be identified on Figure 2 through the property addresses listed below in each of the subsections.

3.3.1 Walerko Tool & Engineering

Walerko Tool & Engineering (Walerko) is a registered ISO9002 tool and engineering company. Walerko commenced business operations in 1952 and is engaged in manufacturing machining, tool and die work at its plant located at 1935 West Lusher Avenue. Walerko used the cleaning solvent TCA as a parts cleaner in Walerko's manufacturing process. Periodically, when the tanks and smaller containers of solvent became dirty, Walerko employees disposed of the spent solvent outside of the facility onto the ground, and then refilled the containers with fresh solvent. In 1987, the drinking water well located at Walerko indicated the presence of TCA at a concentration of 660 parts per billion (ppb) and TCE at a concentration of 38 ppb. In 2007, an inspection along the eastern sector of the facility revealed dark oil stained soils beneath several dumpsters containing scrap metal. EPA identified Walerko Tool & Engineering Company (Walerko) liable for the ground water contamination around Lusher Street. On September 24, 1993, EPA filed a Cost Recovery Consent Decree with Walerko Tool & Engineering Corporation. The consent decree filed a complaint pursuant to Sections 104(e) and 107 of the Comprehensive Environmental Response, Compensation, Liability Act of 1980, as amended ("CERCLA"), 42 U.S.C Sections 9604(e) and 9607, and Section 3007 of the Resource Conservation and Recovery Act ("RCRA"), 42 U.S.C. Section 6927. The United States was seeking reimbursement of response costs incurred by EPA and the Department of Justice for response actions in connection with the release or threatened release of hazardous substances, including TCA and TCE, at the Lusher Street Site and civil penalties for Walerko's failure to timely respond to EPA's information requests dated March 26, 1990. On July 20, 1993, Walerko agreed to enter into the consent decree provided a settlement schedule for payment of past costs \$125,330 and a civil penalty \$19,670.

3.3.2 Flexible Foam Products

Flexible Foam Products is located at 1900 W. Lusher Avenue. The company was originally known as Indiana Foam. The company appears to be a subsidiary of Ohio Decorative Products, Inc., since 1971. The company currently manufactures polyurethane foam and is a supplier of foam and foam products for residential and commercial applications. Toluene diisocyanate is used to manufacture the foam. Other substances used at the facility include carbon dioxide (which replaced methylene chloride), colorants, fire retardants, ethyl acetone naphtha, tin, and Poly All, which is supplied by Bayer. It would appear that TCA was also used at the facility in 1991 as exhibited by Flexible Foam Products Toxics Release Inventory.

3.3.3 Gaska Tape

Gaska Tape is located at 1810 W. Lusher Avenue. This company is a poly vinyl chloride (PVC) foam manufacturer. The company began operations in 1965. Gaska Tape is a manufacturer of closed-cell foams and adhesive tapes (PVC Foam, Polyester Foam and Gaska Hi Bond® Adhesive Tapes). TCE had been used at the site as a support solvent for suspending silicone as a release coating agent. The company also uses oil base plasticizers in its manufacturing processes. The company utilizes the services of D&B Environmental Services to dispose of its waste material. The facility was formerly a RCRA large quantity generator of hazardous waste but is now a small quantity generator. The facility uses a regenerative thermo oxidizer that burns VOCs before they go into the air. A dry pond is located in a wooded area north of the plant building and captures any runoff from the facility. This pond is not lined.

3.3.4 Action Auto Salvage

The facility accepts salvageable vehicles and sells them for parts. The company is located at 1750 W. Lusher Avenue. At times the facility sells entire vehicles to scrap yards. The company started operations three (3) years ago. Other businesses that occupied the property prior to Action Auto Salvage include Fidler Concrete Company, BFI Waste Management, First Step Finance, and an automotive repair shop. Substances currently used on site include antifreeze and hydraulic oil (15-40 Shell Rotella). A company representative stated that no degreasers or cleaners are used.

3.3.5 Facility at 1706 West Lusher Avenue

This facility at 1706 West Lusher Avenue appeared to be vacant and there is no information on file for this facility at this time.

3.3.6 Atlas Chemical Milling

The company is a division of Atlas Die and specializes in flexible dies for reciprocating or rotary application for hundreds of companies in a number of industries. The company is located at 1627 W. Lusher Avenue. The company etches steel for labels and boxes. Dies are manufactured to cut out various materials for converters. Converters make paper into types of products. The finish steel is cleaned, laminated, etched, and coated. Silver halide is applied to produce specified images on the steel. Chemicals used include acetone base paint, toluene, and acids. Hazardous wastes are handled by Dynecol (part of PVS Chemical in Detroit), and Univar based in Chicago. The company also utilizes its own water treatment facility which treats all water before it discharges it to the municipal waste water treatment plants. It should be noted that large crevasses were observed in the floor in parts of the plant building as a result of acids leaking from vats. Drinking water is supplied by the city municipal water system. The company has several onsite monitoring wells.

3.3.7 Holland Metal Fabricating

The Holland Manufacturing Fabricating company is a steel manufacturer for the mobile home industry. The company is located on 1550 W. Lusher Avenue. The company has been in business for over 10 years. This facility produces frames, cross members, and front ends. Bed rails for pickup trucks are also manufactured. The company utilizes the services of Michiana Industrial Lubricants to change out spent oils within their machines. Municipal water is used for drinking water. The facility utilizes a septic system. Only soaps are used. A site representative indicated that no solvents are used in their processes.

3.3.8 Colbert Packaging

The Colbert Packaging company is a cardboard manufacturing company that prints and folds cartons for various products. The company is located at 1511 W. Lusher Avenue. Other services the company performs includes structural design and CAD/CAM sample making, full prepress, in-house sheeting, printing, die making, die cutting, gluing and windowing. Approximately 30% of the boxes are manufactured for the food industry, 50% for hardware, and 20% for miscellaneous goods (i.e., computer software.). The facility uses 1,2,4-trimethyl benzene and 1,3,5-trimethylbenzene based solvents to clean the ink on the rockers. Isopropanol and some oils are also used in the manufacturing process. The company utilizes a backhouse dust collector to capture paper dust. Waste is handled by HIMCO and D&B Environmental. This company has been at this location for the past 25 years. The company uses the municipal water system for drinking water.

3.3.9 The Sturgis Metal (aka Elkhart Metal)

The Sturgis Metal (aka Elkhart Metal) is located at 1514 W. Lusher Avenue. The company is a metal recycling facility. The facility accepts and purchases ferrous and nonferrous scrap metal. The facility utilizes hydraulic oils, diesel fuel, antifreeze, transmission fluid, and solvents for a parts washer. Most of these fluids are stored in the maintenance building. All generated waste is handled by Safety Clean. In 2006, soil samples were collected by IDEM's Enforcement section at the Sturgis Metals facility to address some citizen complaints. Analysis of the soil revealed cis 1,2-DCE at an estimated concentration of 1.6J ug/kg and PCE in an autofluff sample was estimated at a concentration of 170J ug/kg .

3.3.10 Bristol Auto Parts West

Bristol Auto Parts West primarily sells automotive parts and accessories. The company is located at 1422 W. Lusher Avenue. There is no use of solvents or cleaners at this business. This business has been at this location for the past 28 years. This business operated a small machine shop more than 18 years ago. The site representative had stated that the Auto Trade Center was once located adjacent and to the east of their property approximately 5 to 6 years ago. Oil and antifreeze were observed to have been dumped on the ground at that facility.

3.3.11 Cullip Industries

Cullip Industries, Inc. was founded in 1959 as a small tool die job shop as Cullip Tool & Die Inc. The Cullip Industries is located at 1900 Fieldhouse Avenue. In 1982, the company invested in CNC equipment. In 1990 a machining division was started. The company also specializes in stamping, blanking, pierce & cutoff, and progressive dies. Water soluble cutting oil (including HocutV4000) and vegetable base coolants are used in the machinery process. No degreasers are used. The company uses Amosol for cleaning purposes. The company also uses a parts washer. Wastes are handled by Usher Oil (formerly Berreth Oil) based out of Detroit, Michigan. The municipal water system supplies drinking water to the facility.

3.3.12 B-D Industries, Inc.

B-D Industries, Inc. is located at 1715 Fieldhouse Avenue. The company was founded in 1979. The facility processes metal castings for the aerospace industry. The types of castings that the company works on include landing gears, brake parts, and other parts for 747s, 737s, and other planes. Parts are cleaned and put in tanks of sulfuric acid as part of a plating/anodizing process (as the company representative stated: The company changes the molecular structure of aluminum to aluminum oxide for corrosion protection). Sulfuric acid, nitric acid, sodium hydroxide, hydrogen chloride (HCl), methyl ethyl ketone (MEK), and TCE are liquids that the company utilizes in their processing. All hazardous wastes are sent off by Safety Clean twice a year. The company also uses some hydraulic oils.

3.3.13 Elkhart Plating

There is no information on file for the facility located at 1913 South 14th Street.

3.3.14 Zurn Facility

There is no information on file for the facility located at 1900 West Hively Avenue.

3.3.15 Adorn Facility

There is no information on file for the facility located at 1808 West Hively Avenue.

3.3.16 Forest River, Inc.

Forest River is a manufacturer of Class A diesel motor homes. The company is located on 1800 W. Hively Avenue. This business has been at this location since 2003. The chassis, engines, and transmissions are purchased and Forest River, Inc. installs the floors, walls, ceilings, and all furnishings (which includes installing fiberglass laminates, electrical wiring, and appliances). Some

aluminum welding is performed in this process. The company applies adhesives, carpeting, and conducts some painting activities. Waste from the company operations includes paint solvents, antifreeze, and oils. All wastes are handled by D&B Environmental. No chlorinated solvents are used. The property was utilized by Skyline Mobile Home Inc. prior to Forest River Inc. operations.

3.3.17 Conrail Right of Way

There is no information on file for the Conrail right-of-way (ROW) area.

3.3.18 Dump North of Conrail Right-Of-Way

There is no information on file for the dump north of the Conrail ROW area.

3.3.19 WeVac Plastics

WeVac Plastics was founded in 1989 to service the recreational vehicle (RV) industry. The company is located at 2401 South 17th Street. WeVac Plastics also provides custom thermoforming, silk-screening, secondary assembly, five axis CNC trimming and other services. The company has its own in-house tooling shop, product development department, and pattern cutting five (5) axis CNC. The facility consists of a 73,000 square foot building and 40 employees. Materials that WeVac Plastics handles are ABS, high density polytetrafluoroethylene, high impact polystyrene, polycarbonate, and laminated foils, (i.e. brushed aluminum, marble, wood grain). The company uses a two (2) epoxy glue that contains MEK and acetone. No chlorinated solvents are used. The company utilizes the city municipal water system for drinking water. It should be noted that company staff had just extinguished a fire prior to the inspection.

3.3.20 K.G. Gemeinhardt Company, Inc.

From the 1940s through 1977, K.G. Gemeinhardt Company, Inc., (Gemeinhardt), and its predecessors, owned and operated manufacturing facilities on a three-acre site at 57882 State Route 19. Gemeinhardt is located on Route 19 approximately 0.75 miles south of Lusher Avenue. Gemeinhardt manufactures musical instruments. In the process of manufacturing these instruments, Gemeinhardt used TCA, TCE, and PCE, which are chlorinated VOCs. In 1985, Gemeinhardt agreed to an interim remedial action, whereby Gemeinhardt shall conduct an investigation sufficient to fully characterize the sources and extent of ground water identified to the north-north-west of the facility. While conducting an extent of contamination study at Gemeinhardt under the terms of the 1985 Consent Order with the EPA, VOCs were detected in private drinking water wells in an area immediately south of Lusher Avenue. At the time of this investigation, Gemeinhardt believed that the contamination in this area was independent of the Gemeinhardt ground water plume. High levels of chlorinated solvents have been used at the Gemeinhardt facility. The chlorinated solvents detected in the drinking water wells included primarily TCE and PCE.

Gemeinhardt produced process waste streams, which were disposed of on the facility. The process wastes drained to various sumps that pump the wastes to several dry wells, to a gravel seepage bed, or to a septic tank at the facility. These wastes were then allowed to seep into the ground and the shallow underlying aquifer. Gemeinhardt produced approximately 2,500 gallons of wastewater per operating day that were formerly pumped to the various seepage systems. Sometime prior to December 25, 1984, Gemeinhardt ceased all wastewater discharges to the dry wells. Gemeinhardt removed approximately 1,000 cubic yards of contaminated soil from the facility. As of January 8, 1985, Gemeinhardt contracted with the city of Elkhart to dispose of its wastewater at the Elkhart Municipal Wastewater Treatment Plant. In 1988, Gemeinhardt completed a comprehensive hydrogeological study which found TCA, TCE, and PCE in the ground water at, and downgradient of, Gemeinhardt and a plume containing these VOCs extending north-northwest from the Gemeinhardt plant. The hydrogeological report also found evidence of at least one other source of these VOCs unrelated to the Gemeinhardt facility. On January 23, 1990, EPA and IDEM issued an Administrative Order by Consent which required Gemeinhardt to undertake and complete certain response actions, including removal and treatment of ground water, to prevent the migration of hazardous substances in ground water and to prevent exposure to ground water containing hazardous substances. The recommended action consisted of installing three recovery wells and a treatment facility to remove and treat contaminated ground water containing chlorinated VOCs .

3.4 Contaminants of Concern / Target Analytes

The primary identified contaminants of concern include the chlorinated VOCs: TCE, TCA, trans 1,2-DCE), cis 1,2-DCE, 1,1-DCE, and PCE. Therefore, VOCs are the only analytes and/or classes of compounds to be sampled for and/or monitored.

4.0 Project Description and Schedule

WESTON's drilling subcontractor(s) is not procured at this time. The drilling subcontractor(s) will perform the following site activities:

- Clear each drilling location for the presence of underground utilities through Indiana's one-call system (Indiana Underground Plant Protection).
- Advance approximately 108 soil borings at approximately 20 different properties to approximately 5 feet below the water table utilizing a track-mounted Geoprobe® or equivalent direct push drill rig. Each soil boring is estimated to be advanced to approximately 25 feet below ground surface (bgs) as continuous soil samples are collected for lithologic logging. Soil and groundwater samples for analytical testing will be collected from each boring location. Soil samples will be collected from each 5-foot depth interval. Groundwater will be sampled using a small diameter bladder pump. Groundwater samples will be collected from either a temporary monitoring well installed through the Geoprobe rods (dual tube system), or through an exposed screen attached to the drilling rods (such as Geoprobe's Screen Point 15/16 Groundwater Samplers). A small diameter bailer will be an alternate groundwater sampling device.

- Convert and develop approximately seven soil borings into temporary piezometers to obtain water table elevation for groundwater flow directions.
- Manage all investigation-derived waste (IDW), including personal protective equipment (PPE), soil cuttings, and wastewater, generated from decontamination and well purging activities. The IDW will be temporarily stored at location identified by the U.S. EPA RPM.

A U.S. EPA contract laboratory program (CLP) laboratory will provide analytical services. Sample labels and chains-of-custody (COC) will be generated using the Forms II Lite software. Samples will be packaged properly using bubble wrap and shipped either daily or every other day for next-day delivery. The turnaround time for analytical reports will be determined at the time of CLP laboratory procurement. The samples will be reviewed and validated by a U.S. EPA chemist. A summary report of the soil and groundwater investigation will be submitted to U.S. EPA within 45 days of receipt of the final set of validated data from the U.S. EPA.

The access to the properties under investigation will be obtained by the U.S. EPA.

5.0 Project Quality Objectives

5.1 Project Objectives

The purpose of site activities is to characterize geologic conditions and the presence of VOC contamination within and around the Site. The specific objectives for this project include:

- Identifying potentially responsible parties.
- Gathering data to determine whether a removal action is warranted, and, if so, whether the response should be classified as an emergency, time-critical, or non-time critical removal action.
- Gathering data to rapidly assess and evaluate the nature, magnitude, and urgency of a release or threatened release of hazardous substances, pollutants, or contaminants, and their effects on human health and the environment.
- Supplying the Agency for Toxic Substances and Disease Registry or others with information about the nature and magnitude of any health threat and to support subsequent public health advisories.

5.2 Measurement and Performance Criteria

Generic measurement and performance criteria described in the *QAPP* will be used to ensure that data are sufficiently sensitive, precise, accurate, and representative to support site decisions.

5.3 Data Quality Objectives (Decision Statements)

Data quality objectives address requirements that include when, where, and how to collect samples, the number of samples, and the limits on tolerable error rates. These steps should periodically be revisited as new information about a problem is learned. The data quality objectives are presented in the *QAPP*.

6.0 Sampling Design

Sampling activities are tentatively scheduled to commence during February of 2009. WESTON START will perform the site activities detailed in the following subsections. The number of soil borings to be advanced at each facility are described in the remainder of Section 6.0 and the well installation, and soil and groundwater sampling procedures are described in Sections 6.1 and 6.2.

6.0.1 Investigation at the Walerko Tool Facility (1935 West Lusher Avenue)

Six soil borings are planned for this facility. Proposed soil and groundwater sampling locations are described below and illustrated on Figure 2.

- There are three boring locations along the north property boundary. Soil and groundwater samples will be collected from each location.
- There is one boring location along the east property boundary. Soil and groundwater samples will be collected from this location.
- There is one boring location along the west property boundary. Soil and groundwater samples will be collected from this location.
- There is one boring location along the south property boundary in the parking lot south of the facility. This boring is likely to be located on the adjacent property and access will likely be required to enter this property. Soil and groundwater samples will be collected from this location.

6.0.2 Investigation at the Flexible Foam Facility (1900 West Lusher Avenue)

Five soil borings are planned for this facility. Proposed soil and groundwater sampling locations are described below and illustrated on Figure 2.

- There are two boring location along the north property boundary. Soil and groundwater samples will be collected from each location.
- There is one boring location along the east property boundary. Soil and groundwater samples will be collected from this location.
- There is one boring location along the west property boundary. Soil and groundwater samples will be collected from this location.

- There is one boring location along the south property boundary. Soil and groundwater samples will be collected from this location, and a temporary piezometer will be installed in this soil boring.

6.0.3 Investigation at the Gaska Facility (1810 West Lusher Avenue)

Five soil borings are planned for this facility. Proposed soil and groundwater sampling locations are described below and illustrated on Figure 2.

- There are two boring locations along the north property boundary. Soil and groundwater samples will be collected from each location.
- There is one boring location along the east property boundary. Soil and groundwater samples will be collected from this location.
- There is one boring location along the west property boundary. Soil and groundwater samples will be collected from this location.
- There is one boring location along the south property boundary. Soil and groundwater samples will be collected from this location.

6.0.4 Investigation at the Action Auto Salvage Facility (1750 West Lusher Avenue)

Five soil borings are planned for this facility. Proposed soil and groundwater sampling locations are described below and illustrated on Figure 2.

- There are two boring locations along the north property boundary. Soil and groundwater samples will be collected from each location.
- There is one boring location along the east property boundary. Soil and groundwater samples will be collected from this location.
- There is one boring location along the west property boundary. Soil and groundwater samples will be collected from this location.
- There is one boring location along the south property boundary. Soil and groundwater samples will be collected from this location.

6.0.5 Investigation at the Vacant Facility (1706 West Lusher Avenue)

Four soil borings are planned for this facility. Proposed soil and groundwater sampling locations are described below and illustrated on Figure 2.

- There are two boring locations along the north property boundary. Soil and groundwater samples will be collected from each location.
- There is one boring location along the east property boundary. Soil and groundwater samples will be collected from this location.

- There is one boring location along the south property boundary. Soil and groundwater samples will be collected from this location.

6.0.6 Investigation at the ATLAS Chemical Milling Facility (1627 West Lusher Avenue)

Five soil borings are planned for this facility. Proposed soil and groundwater sampling locations are described below and illustrated on Figure 2.

- There is one boring location along the north property boundary. Soil and groundwater samples will be collected from this location, and a temporary piezometer will be installed in this soil boring.
- There is one boring location along the east property boundary. Soil and groundwater samples will be collected from this location.
- There are two boring locations along the west property boundary. Soil and groundwater samples will be collected from each location.
- There is one boring location along the south property boundary. Soil and groundwater samples will be collected from this location.

6.0.7 Investigation at the Holland Metal Fabricating Facility (1550 West Lusher Avenue)

Five soil borings are planned for this facility. Proposed soil and groundwater sampling locations are described below and illustrated on Figure 2.

- There is one boring location along the north property boundary. Soil and groundwater samples will be collected from this location.
- There is one boring location along the east property boundary. Soil and groundwater samples will be collected from this location.
- There are two boring locations along the west property boundary. Soil and groundwater samples will be collected from each location.
- There is one boring location along the south property boundary. Soil and groundwater samples will be collected from this location.

6.0.8 Investigation at the Colbert Packaging Facility (1511 West Lusher Avenue)

Six soil borings are planned for this facility. Proposed soil and groundwater sampling locations are described below and illustrated on Figure 2.

- There are two boring locations along the north property boundary. Soil and groundwater samples will be collected from each location.

- There is boring locations in east of the facility in the parking lot located east of 15th Street. This boring is may be located on the adjacent parking lot and additional access may be required to enter this property. Soil and groundwater samples will be collected from each location.
- There is one boring location along the west property boundary. Soil and groundwater samples will be collected from this location.
- There are two boring locations along the south property boundary. Soil and groundwater samples will be collected from each location.

6.0.9 Investigation at the Sturgis Facility (1514 West Lusher Avenue and 1819 14th Street)

Twelve soil borings are planned for this facility. Proposed soil and groundwater sampling locations are described below and illustrated on Figure 2.

- There are five boring locations along the north property boundary of the 1514 West Lusher Avenue property and adjacent to the Conrail ROW. Soil and groundwater samples will be collected from each location, and one soil boring, shown in red on Figure 2, will be converted to a temporary piezometer.
- There is one boring location along the east property boundary of the 1514 West Lusher Avenue property, near the northern end of 13th Street. Soil and groundwater samples will be collected from this location.
- There is one boring location along the west property boundary of the 1514 West Lusher Avenue property. Soil and groundwater samples will be collected from this location.
- There is one boring location along the south property boundary of the 1514 West Lusher Avenue property, north of 1550 West Lusher Avenue property. Soil and groundwater samples will be collected from this location.
- There are two boring locations along the east property boundary of the 1819 14th Street property. Soil and groundwater samples will be collected from each location.
- There are two boring locations along the south property boundary of the 1819 14th Street property. Soil and groundwater samples will be collected from each location.

6.0.10 Investigation at the Bristol Auto Facility (1422 West Lusher Street)

Five soil borings are planned for this facility. Proposed soil and groundwater sampling locations are described below and illustrated on Figure 2.

- There are two boring locations along the north property boundary. Soil and groundwater samples will be collected from each location.

- There is one boring location along the east property boundary. Soil and groundwater samples will be collected from this location, and a temporary piezometer will be installed in this soil boring.
- There is one boring location along the west property boundary. Soil and groundwater samples will be collected from this location.
- There is one boring location along the south property boundary. Soil and groundwater samples will be collected from this location.

6.0.11 Investigation at the Cullip Industries Facility (1900 Fieldhouse Avenue)

Four soil borings are planned for this facility. Proposed soil and groundwater sampling locations are described below and illustrated on Figure 2.

- There is one boring location along the north property boundary. Soil and groundwater samples will be collected from this location.
- There is one boring location along the east property boundary. Soil and groundwater samples will be collected from this location.
- There is one boring location along the west property boundary. Soil and groundwater samples will be collected from this location.
- There is one boring location along the south property boundary. Soil and groundwater samples will be collected from this location.

6.0.12 Investigation at the B-D Industries Facility (1715 Fieldhouse Avenue)

Five soil borings are planned for this facility. Proposed soil and groundwater sampling locations are described below and illustrated on Figure 2.

- There are two boring locations along the north property boundary. Soil and groundwater samples will be collected from each location.
- There is one boring location along the east property boundary. Soil and groundwater samples will be collected from this location.
- There is one boring location along the west property boundary. Soil and groundwater samples will be collected from this location.
- There is one boring location along the south property boundary. Soil and groundwater samples will be collected from this location.

6.0.13 Investigation at the Elkhart Plating Facility (1913 14th Street)

Six soil borings are planned for this facility. Proposed soil and groundwater sampling locations are described below and illustrated on Figure 2.

- There are two boring locations along the north property boundary. Soil and groundwater samples will be collected from each location.
- There is one boring location along the east property boundary. Soil and groundwater samples will be collected from this location.
- There is one boring location along the west property boundary. Soil and groundwater samples will be collected from this location.
- There are two boring locations along the south property boundary. Soil and groundwater samples will be collected from each location.

6.0.14 Investigation at the ZURN Facility (1900 West Hively Avenue)

Five soil borings are planned for this facility. Proposed soil and groundwater sampling locations are described below and illustrated on Figure 2.

- There are two boring locations along the north property boundary. Soil and groundwater samples will be collected from each location.
- There is one boring location along the east property boundary. Soil and groundwater samples will be collected from this location.
- There is one boring location along the west property boundary. Soil and groundwater samples will be collected from this location
- There is one boring location along the south property boundary. Soil and groundwater samples will be collected from this location, and a temporary piezometer will be installed in this soil boring.

6.0.15 Investigation at the ADORN Facility (1808 West Hively Avenue)

Five soil borings are planned for this facility. Proposed soil and groundwater sampling locations are described below and illustrated on Figure 2.

- There are two boring locations along the north property boundary. Soil and groundwater samples will be collected from each location.
- There is one boring location along the east property boundary. Soil and groundwater samples will be collected from this location.
- There is one boring location along the west property boundary. Soil and groundwater samples will be collected from this location.
- There is one boring location along the south property boundary. Soil and groundwater samples will be collected from this location.

6.0.16 Investigation at the Forest River Facility (1800 West Hively Avenue)

Five soil borings are planned for this facility. Proposed soil and groundwater sampling locations are described below and illustrated on Figure 2.

- There are two boring locations along the north property boundary. Soil and groundwater samples will be collected from each location.
- There is one boring location along the east property boundary. Soil and groundwater samples will be collected from this location, and a temporary piezometer will be installed in this soil boring.
- There is one boring location along the west property boundary. Soil and groundwater samples will be collected from this location.
- There is one boring location along the south property boundary. Soil and groundwater samples will be collected from this location.

6.0.17 Investigation along the Conrail Right-of-Way

Four soil borings are planned for this facility. Proposed soil and groundwater sampling locations are described below and illustrated on Figure 2.

- There are two boring locations along the north railroad ROW. Soil and groundwater samples will be collected from each location, and a temporary piezometer will be installed in the western-most soil boring.
- There are two boring locations along the south railroad ROW. Soil and groundwater samples will be collected from each location.

6.0.18 Dump North of Conrail Right-of-Way

At this time, the exact location of the dump is not known; therefore, boring locations have not been depicted on a figure. Depending on accessibility, approximately five soil borings will be installed.

- Two boring locations along the north property boundary (potential downgradient locations). Soil and groundwater samples will be collected from each location.
- There is one boring location along the east property boundary (potential side-gradient location). Soil and groundwater samples will be collected from this location.
- There is one boring location along the west property boundary (potential side-gradient location). Soil and groundwater samples will be collected from this location.
- There is one boring location along the south property boundary (potential upgradient location). Soil and groundwater samples will be collected from this location.

6.0.19 WeVac Plastics (2401 South 17th Street)

Five soil borings are planned for this facility. Proposed soil and groundwater sampling locations are described below and illustrated on Figure 2.

- There are two boring locations along the north property boundary. Soil and groundwater samples will be collected from each location.
- There is one boring location along the east property boundary. Soil and groundwater samples will be collected from this location.
- There is one boring location along the west property boundary. Soil and groundwater samples will be collected from this location.
- There is one boring location along the south property boundary. Soil and groundwater samples will be collected from this location.

6.0.20 K.G. Gemeinhardt Company Inc.

Five soil borings are planned for this facility. The sample locations for this site will be determined in the field with consultation with the U. S. EPA. RPM.

6.0.21 Additional Facilities

Additional facility may be added by the U.S. EPA at a later time for investigation (note: it is assumed that 2 facilities will be added by the U.S. EPA). It is estimated that approximately five soil borings will be installed at each additional facility.

- Approximately two boring locations along the north property boundary. Soil and groundwater samples will be collected from each location.
- Approximately one boring location along the east property boundary. Soil and groundwater samples will be collected from this location.
- There is one boring location along the west property boundary. Soil and groundwater samples will be collected from this location.
- There is one boring location along the south property boundary. Soil and groundwater samples will be collected from this location.

6.1 Temporary Piezometer Installation

Approximately seven soil borings will be converted into temporary piezometers to determine groundwater flow direction. The proposed soil borings that will be converted into piezometers are shown on Figure 2.

6.2 Soil Boring Using Direct-Push Equipment

Sampling locations will require the use of a direct-push, Geoprobe or equivalent, drilling rig, based on cost and time benefits of this technology. The use of a Geoprobe or equivalent rig is proposed for approximately twenty facilities. The subject locations are illustrated on Figure 2.

6.2.1 Soil Boring Advancement Procedures

Soil borings will be required to collect soil samples at various depths. Decontamination will be in accordance with subsection 7.3 of this SAP. All work will be performed under the direction of a WESTON field geologist. The following procedures will be used to facilitate soil and groundwater sampling, which are described in sections 6.2.2 and 6.2.3 below:

- Prior to commencement of any drilling, a WESTON field geologist will ensure that the utility clearance is requested and utility markings are observed by the drilling subcontractor.
- Prior to commencing soil boring activities at any location, the drilling subcontractor will decontaminate the working end of the drilling rig. All drilling equipment and tools will be rinsed using a high-pressure steam cleaner. The drilling subcontractor will avoid placing equipment, tools, and materials on the ground during soil boring activities. The standard decontamination protocol for investigative boring equipment is presented in Subsection 7.3 of this SAP.
- The drilling subcontractor will advance each soil boring to the desired depth (5-feet below groundwater table), estimated to be 25 feet bgs, or until probe refusal, whichever is shallower. If refusal occurs before reaching the water table, the probe will be relocated to a nearby location determined by WESTON Geologist. Soil samples will be collected on a continual basis using disposable macrocore (*i.e.*, polyethylene) liners. The depth of the groundwater table will be inferred based on saturated conditions encountered in the soil samples.
- To facilitate groundwater sampling either a temporary monitoring well will be installed approximately 5 feet below the water table, or the bottom of an exposed screen, such as the Geoprobe Screenpoint 15/16 sampling system, will be driven to approximately 5 feet below the water table and retraced to expose to screen. The actual screened interval will be recorded in the logbook.
- Soil borings will be abandoned by filling the borehole with granular bentonite. Soil cuttings will be placed in 55-gallon drums and temporarily placed, by the drilling subcontractor, in a secured staging area located on the Site. Management of these drums will be conducted according to the requirements specified in Section 6.8 of this SAP. Each location will be resurfaced to pre-existing conditions by the drilling subcontractor.

6.2.2 Soil Sampling Procedure

Soil samples will be collected using the following procedures.

- All non-dedicated equipment that contacts the samples will be decontaminated between sample collections in accordance with the requirements outlined in Subsection 7.3 of this SAP.
- Following removal from the borehole, each disposable macrocore liner will be opened on a clean surface (e.g., polyethylene sheeting), and each soil core will be qualitatively screened for VOCs utilizing a photo-ionization detector (PID).
- Soil samples will be acquired for VOC analysis from each 5 foot long soil core immediately upon completion of PID screening. The sample interval exhibiting the greatest PID readings will be collected for laboratory analysis. In the event that there are no elevated PID readings from a given 5-foot long depth interval, the sampling interval will be determined by the field geologist and will be based on the stratigraphy, soil staining, odor, or other factors, such as top of any fine-grained deposits encountered.
- Sample material from the selected, undisturbed sample interval will be collected in three five-gram Encore samplers. No mixing or compositing will be performed on the sample material, thereby limiting potential VOC loss. The Encore samples will be immediately placed in a cooler with ice.
- Additional soil from the same, sampled interval will be collected and placed in a sealable plastic baggie (Ziploc or equivalent). The plastic bag will then be placed in a warm area for at least 30 minutes prior to checking the head space with a PID. The concentrations of VOCs in the head space will be recorded in the logbook. This will continue for all cores collected at a given boring.
- One soil sample will be collected at, or immediately above the saturated zone using Encore samplers as described above.
- Additional soil samples may be submitted for laboratory analysis depending on PID results and/or field observations.
- Soil samples will be maintained at 4°C with ice after sample collection.
- A qualified WESTON geologist will describe each soil sample in accordance with American Society for Testing and Materials (ASTM) method D2488. The lithology for each boring will be classified using the Unified Soil Classification System (USCS).

It is assumed that each soil boring will be advanced to approximately 25 feet bgs, and that the water table will be encountered at 20 feet bgs. Therefore, five soil samples are expected to be collected from each boring. The estimated number of soil samples and corresponding analyses are presented in Table 2.

6.2.3 Groundwater Sampling From Soil Borings

One groundwater sample will be collected from each boring through a temporary well or an exposed screen using a bladder pump. In the event that a bladder pump cannot yield sufficient water for sampling purposes (and only in that event), a bailer will be used for groundwater sampling purposes. Each groundwater sample will be collected using the following procedures:

- Prior to commencing with groundwater sampling activities, the water level and total depth for each boring and temporary monitoring well will be measured with an electrical sounding device (accuracy ± 0.01 feet). The sounding device will be slowly lowered and raised through the water column to minimize the potential for volatile loss. The depth to water, total depth, and the time of measurement will be recorded. The reference point for these depths will be the top of the ground surface.
- The borings and temporary monitoring wells will be purged with the bladder pump at a flow rate not to exceed 150 milliliters per minute and an attempt will be made to minimize drawdown. Field parameters, including pH, temperature, specific conductance, turbidity, dissolved oxygen (DO) and oxidation reduction potential (ORP), will be measured through a flow through cell. Field parameter measurements will be recorded by a WESTON field staff member at approximate five-minute intervals. Sampling will commence following the removal of three well volumes and after at least three sets of field parameters have been measured.
- If insufficient groundwater is available and purging depletes the borehole and/or temporary monitoring well of groundwater, the boring and/or temporary monitoring well will be allowed to recharge for 15 minutes, or until the water level is within 0.5 ft of the original water level, and will then be purged dry again. A sample will be collected as soon as the borehole and/or monitoring well have recharged enough for sample collection.
- The pump tubing will be disconnected from the flow through cell and samples will be collected directly from the pump tubing after purging has been completed. Samples will be analyzed for VOCs. All samples will be collected unfiltered.
- In the event a bladder pump cannot yield sufficient water for sampling purposes (and only in that event), a small-diameter bailer will be used for groundwater purging and sampling purposes. The above-described procedures will be used. Parameter readings, with the exception of DO, will be measured by inserting the probes into an open container.
- Volatile organic analyte (VOA) sample bottles will be filled at an angle in order to limit splashing and bubbling. The VOA sample bottles will be filled such that no air space is present in the bottle after it is capped. If bubbles appear after the bottle is capped, a new sample will be collected. A new, preserved VOA container will be used to collect the sample. If bubbles persist, an unpreserved sample will be collected (the field sample manager will note the absence of the preservative on the sample paperwork and in the field logbook).

- Samples will be maintained at 4°C with ice after sample collection.
- Decontamination of all non-disposable groundwater sampling equipment will be completed in accordance with subsection 7.3 of this SAP.

The estimated number of groundwater samples, sample container, volume, and preservation requirements are presented in Table 2.

6.2.4 Existing Monitoring Well Sampling

If monitoring wells are discovered on any of the property, they will be sampled. One groundwater sample will be collected from each monitoring well using a bladder pump. Each groundwater sample will be collected using the following methodology:

- Prior to commencing with groundwater sampling activities, the water level and total depth will be measured with an electrical sounding device (accuracy ± 0.01 feet). The depth to water and the time of measurement will be recorded. The reference points for these measurements will be the top of the well casing and the ground surface.
- A bladder pump equipped with clean, disposable tubing will be used for purging and sampling. WESTON will attempt to place the pump intake within the screened interval, or few feet from the bottom of the monitoring well and within the saturated part of the well screen, if construction details are unavailable. If the water column length or groundwater recharge to the boring is insufficient to support bladder pump purging and sampling, an alternate purging and sampling method may be substituted. Decontamination will be completed in accordance with subsection 7.3 of this SAP.
- The monitoring well will be purged at a flow rate between 100 and 150 milliliters per minute and an attempt will be made to minimize drawdown. Stabilization parameters, including pH, temperature, specific conductance, turbidity, dissolved oxygen (DO) and oxidation reduction potential (ORP), will be measured through a flow through cell. Stabilization parameters will be recorded by a WESTON field staff member at approximate five-minute intervals. Purging will continue until the measurements for all six field parameters have stabilized for three consecutive readings to within the following ranges: ± 0.1 standard unit (s.u.) for pH, ± 10 percent (%) for specific conductance, ± 1 degrees Celsius ($^{\circ}\text{C}$) for temperature, 10% for DO, 10% for ORP, and either 10% for turbidity or less than 10 nephelometric turbidity units (NTU). A maximum of five well volumes will be purged from each monitoring well prior to collecting a groundwater sample.
- If insufficient groundwater is available and/or the monitoring well is purged dry before it stabilizes, the monitoring well will be allowed to recharge for 15 minutes and then will be pumped dry again and allowed to recharge before sampling.
- Samples will be collected directly from the pump tubing after purging has been completed. Samples will be analyzed for VOCs. All samples will be collected unfiltered.

- Volatile organic analyte (VOA) sample bottles will be filled at an angle in order to limit splashing and bubbling. The VOA sample bottles will be filled such that no air space is present in the bottle after it is capped. If bubbles appear after the bottle is capped, the bottle and sample will be discarded, and a new sample will be collected in a new, preserved VOA container. If bubbles persist, an unpreserved sample will be collected (the field sample manager will note the absence of the preservative on the sample paperwork and in the field logbook).
- Samples will be maintained at 4°C with ice after sample collection.

The sample container, volume, and preservation requirements are presented in Table 2.

6.3 Sample Numbering System

All samples collected for analytical testing, including QC samples, will be given a unique sample number. The sample numbers will be recorded in the field logbook, the COC, and the shipping documents.

WESTON will assign each sample a project sample number. The project sample number highlights the sample matrix and location. The sample ID will be used for documentation purposes in field logbooks, as well as for presentation of the analytical data in WESTON memoranda and reports. The project sample numbering system will be composed of the following components:

Project Identifier

The first part of the project sample number will consist of a three-character designation.

LGC01 – Lusher Street Groundwater Contamination, Facility 01

Facility Codes are provided below:

01 – Waterko Tool & Engineerint

02- Flexible Foam Products

03- Gaska Tape

04 – Action Auto Salvage

05 – Vacant Property at 1706 Lusher Street

06 – Atlas Chemical Milling

07 – Holland Metal Fabricating

- 08 – Colbert Packaging
- 09 – Sturgis Metal (aka Elkhart Metal)
- 10 – Bristol Auto Parts West
- 11 – Cullip Industries
- 12 – B-D Industries
- 13 – Elkhart Plating
- 14 – Zurn Facility
- 15 – Adorn Facility
- 16 – Forest River Inc.
- 17 – Conrail Right-of Way
- 18 – Dump North of Conrail Right-of-Way
- 19 – WeVac Plastics
- 20 – K.G. Gemeinhardt

Sample Type and Sampling Location

This shall consist of the following:

- A two-character sample-type code. For the proposed types of field sampling, the following codes may be utilized during this phase or subsequent investigation phases, as applicable:
 - › SB – Soil boring subsurface soil sample
 - › GW – Groundwater sample
 - › MW – Monitoring Well
 - › DS – Drum sample – solid
 - › DL – Drum sample – liquid
- A sample location code. The above sample-type code will be combined with sampling location identification (*e.g.*, SB02 for subsurface soil sampling location 2, and GW02 for groundwater sampling location 2). For field blanks and trip blanks, the two-character sample-type code will be combined with FB for field blanks and TB for trip blanks (*e.g.*, GWTB for a groundwater trip blank).

Sequence Identifier

This shall consist of the following:

- A two-digit sequence number that tracks the number of samples collected from a specific location. Sequence 01 refers to the first sample interval, and sequence 02 refers to the second sample interval. Sample depths will not be a part of the sample code; rather, depth information will be recorded in the site field logbook and presented with the analytical results.
- If the sample is a field duplicate sample, the above will be combined with DP. If the sample is a matrix spike/matrix spike duplicate sample, the above will be combined with MSD.
- For field and trip blanks, the two-digit sequence number will denote the sequential number of field or trip blank samples collected for that sample type.
- Field duplicate samples will be submitted without reference to the laboratory (*i.e.*, the laboratory will not be informed that the sample is duplicate).
- Some examples of the WESTON project sample numbering system are as follows:
 - LGC01-SB02-01DP Lusher Street Groundwater Contamination Site Facility 1; soil boring location 2; duplicate of first soil sample collected at this location.
 - LGC01-GW03-01 Lusher Street Groundwater Contamination Site Facility 1; groundwater sample from soil boring location 3; first groundwater sample at this location.
 - LGC01-TMW02-01 Lusher Street Groundwater Contamination Site Facility 1; groundwater sample from temporary monitoring well location 2; first groundwater sample at this location.
 - LGC01-GW01-01MSD Lusher Street Groundwater Contamination Site Facility 1; groundwater sample from soil boring location 1; first sample collected at this location; sample is a matrix spike/matrix spike duplicate sample.

6.4 Management of Investigation-derived Wastes

For purposes of this SAP, IDW are defined as any byproduct of the field activities that are suspected or known to be contaminated with hazardous substances. The performance of field activities will produce waste products such as encore samples not shipped to the laboratory, purged groundwater, decontamination wastewater, drill cuttings, and expendable PPE.

In order to collect the decontamination wastewater, a portable or temporary decontamination pad will be set up at one or more facilities, based on access agreements. Wastewater will be pumped from the decontamination pad, collected, and containerized. Wastewater and purge water from the developing and sampling of groundwater will be stored in Department of Transportation-approved drums. Each type of waste will be segregated during field activities and containerized separately.

All storage containers will be labeled appropriately. Wastes will be stored at the location identified by the U.S. EPA for disposal at later time. At a later date, WESTON will make arrangements to dispose of IDW in accordance with local, state, and federal regulations.

7.0 Sampling Procedures

7.1 Sampling Standard Operating Procedures

The following standard operating procedures (SOPs) will be used during the site evaluation:

- 2001 – General Field Sampling Guidelines
- 2006 – Sampling Equipment Decontamination
- 2007 – Groundwater Well Sampling
- 2012 – Soil Sampling
- 2114 – Photoionization Detector
- SOP 204 – Water Level Measurements
- SOP 210 – Field pH, Conductivity, and Temperature Measurement
- SOP 101 – Logbook Documentation
- X001 – Encore Sampling

7.2 Confirmatory Sampling

No confirmatory samples are expected to be collected for this investigation.

7.3 Decontamination Procedures

Decontamination procedures are detailed in the sampling SOPs listed above in Section 7.1 of this SAP. General decontamination procedures are described in the site-specific QAPP. The general decontamination procedures for the Geoprobe are provided below.

The following standard decontamination protocols for drill rig equipment will be used:

1. Move the drill rig or other equipment and materials to the designated decontamination area.
2. Support all related downhole drilling equipment aboveground and individually steam-clean.
3. Steam-clean the control panel and working area of the Geoprobe or equivalent rig.
4. Place all decontaminated Geoprobe or equivalent equipment (*e.g.*, rod, rod tip) on clean polyethylene sheeting until use.

NOTE: All cleaning of investigative equipment will be performed using steam. Steam-cleaning will continue until all solid material and/or visible contamination is removed.

8.0 Sample Handling, Tracking, and Custody Procedures

All samples will be identified, handled, shipped, tracked, and maintained under COC in accordance with the *QAPP*.

9.0 Field Analytical Methods and Procedures

9.1 Field Analytical Methods and Standard Operating Procedures

The detection limits for analysis of the soil and groundwater samples are provided in the site-specific QAPP. Trace-level analysis is requested for the groundwater samples.

9.2 Field Testing Laboratory (if applicable)

A field testing laboratory is not anticipated at this time.

9.3 Field Screening/Confirmatory Analyses

Screening will be performed using a PID. The headspace of plastic bags containing soil samples will be tested using a PID.

10.0 Fixed Laboratory Analytical Methods and Procedures

A U.S. EPA CLP laboratory will be used. The name, address, name of contact person, telephone number, and fax number will be determined prior to Site start-up and information will be added in this section of the sampling plan.

The following procedures and methods will be used:

- CLP SOM01.2 (5035 extraction)
- CLP SOM01.2 (trace level)

NOTE: The U.S. EPA project manager will review and approve the SAP prior to proceeding with lab procurement. Therefore, this information will not be available until the lab procurement has been finalized.

11.0 Quality Control Activities

11.1 Field Quality Control

Field QC samples will be collected and analyzed for this project at the frequency described in the site-specific QAPP. The number of QC samples collected for each analytical parameter and concentration level are listed in **SAP Table 2, Sampling Locations and Sampling and Analysis Summary/Field Quality Control Summary**.

11.2 Analytical Quality Control

QC for analytical procedures will be performed at the frequency described in the site-specific QAPP. In addition, method-specific QC requirements will be used to ensure data quality.

11.3 Performance Evaluation Samples (if applicable)

No performance evaluation samples are expected to be collected for this investigation.

12.0 Documentation, Records, and Data Management

Documentation, record keeping, and data management activities will be conducted in accordance with the site-specific QAPP.

13.0 Quality Assurance Assessment and Corrective Actions

One field audit may be conducted during the early phase of a long-term response activity. Field sampling and field analytical procedures will be assessed for conformance with procedures described in the site-specific QAPP and with this site-specific SAP. Findings will be documented in a report to management. Corrective actions in response to audit findings will be initiated, implemented, and checked according to the QAPP.

Type of Audit:	<u>Field Audit</u>
Date(s) of Audit:	<u>To Be Determined</u>
Performed by What Organization:	<u>WESTON</u>

14.0 Reports to Management

Reports to management will be written and distributed in accordance with the site-specific QAPP.

15.0 Steps 1, 2 and 3: Data Review Requirements and Procedures

Step 1: Data collection activities, including sample collection and data generation, will be verified in accordance with the site-specific QAPP.

Step 2: Data will be validated in accordance with the site-specific QAPP. A U.S. EPA chemist will validate the data. Definitive data will be validated following Tier Level II.

Step 3: Data will be reviewed for usability in accordance with the site-specific QAPP.

SAP Table 1: SAP Revision Form

Site: Lusher Street Site, Elkhart, Elkhart County, Indiana
RPM: Syed Quadri
TDD: S05-0008-0808-008

Date	Rev. #	Proposed Change to SAP/QAPP	Reason for Change of Scope/Procedures	SAP Section Superseded	Requested By	Approved By

SAP Table 2: Sampling Locations and Sampling and Analysis Summary / Field Quality Control Summary

Site: Lusher Street Site, Elkhart, Elkhart County, Indiana

RPM: Syed Quadri

TDD: S05-0008-0808-008

Matrix	Analytical Parameter	Analytical Method	Containers (Numbers, size, and type)	Preservation Requirements	Number of sampling locations	Number of field duplicates	Number of MS/MSD or spike / duplicates	Number of VOA trip blanks	Number of equipment/ rinsate blanks	Total number of samples to lab
Soil	VOCs	CLP SOM01.2 (5035 extraction)	(3) 5-gram Encore Samplers	Ice 14 days to analyze Laboratory to preserve/extract within 48 hours.	117 (585) soil samples)	59 (one duplicate per 10 investigative samples)	30 (one MS/MSD per 20 investigative samples)	NA	NA	644
Groundwater	VOCs	CLP SOM01.2 (trace level)	80 mL- (2) 40-mL VOA vials	HCl to pH<2 Ice	117*	12 (one duplicate per 10 investigative samples)	6 (one MS/MSD per 20 investigative samples)	20 (one per shipment cooler, estimate of 20 coolers)	20 (one per day for 20 days)	169

Note:

If samples will be collected at different depths at the same location, count each discrete sampling depth as a separate sampling location/station.

Trip blanks are included in every shipment of aqueous VOC samples.

* - It is assumed that one groundwater sample will be collected from each soil boring installed using a Geoprobe sampler.

< – Less than

CLP – Contract Laboratory Program

HCl – Hydrochloric Acid

mL – milliliter

MS – Matrix Spike

MSD – Matrix Spike Duplicate

NA – Not Applicable

VOA – Volatile Organic Analysis

VOC – Volatile Organic Compound

Appendix A

Figures

Imagery Source:
http://gis.iu.edu:8080/inmap05_utm_orthos_1m

File: D:\Lusher_Street\mxd\F3_TCE_Results.mxd, 12-Jan-09 09:56, wojdakon



- Legend**
- Sampling Locations
 - Background Locations
 - Site Boundary

NOTES:
All results in ug/L



Prepared for:
U.S. EPA REGION V
Contract No: EP-S5-06-04
TDD: S05-0008-0808-008
DCN: 506-2E-ACWY



Prepared By:
Weston Solutions, Inc.
750 E. Bunker Ct. Suite 500
Vernon Hills, IL 60061

Figure 3
TCE Concentrations
Lusher Street Groundwater Contamination
Elkhart, Elkhart County, Indiana



Legend

- Soil Borings Converted to Temporary Piezometers
- Proposed Soil Boring Locations
- Site Boundary

0 400 Feet



Prepared for:
U.S. EPA REGION V
Contract No: EP-S5-06-04
TDD: S05-0008-0808-008
DCN: 506-2E-ACWY



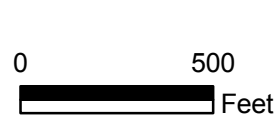
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Figure 2
Proposed Boring Locations
Lusher Street Groundwater Contamination
Elkhart, Elkhart County, Indiana



Legend

 Site Boundary



Prepared for:
U.S. EPA REGION V
Contract No: EP-S5-06-04
TDD: S05-0008-0808-008
DCN: 506-



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Figure 1
Site Location
Lusher Street Groundwater Contamination
Elkhart, Elkhart County, Indiana

Imagery Source:
http://gis.iu.edu:8080
inmap05_utm_orthos_1m



NOTES:

All results in ug/L



Prepared for:
U.S. EPA REGION V
Contract No: EP-S5-06-04
TDD: S05-0008-0808-008
DCN: 506-2E-ACWY



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Figure 4
PCE and 1,1,1-TCA Concentrations
Lusher Street Groundwater Contamination
Elkhart, Elkhart County, Indiana

Appendix B

Site-Specific Standard Operating Procedures



SOIL SAMPLING

SOP#: 2012
DATE: 11/16/94
REV. #: 0.0

1.0 SCOPE AND APPLICATION

The purpose of this standard operating procedure (SOP) is to describe the procedures for the collection of representative soil samples. Analysis of soil samples may determine whether concentrations of specific pollutants exceed established action levels, or if the concentrations of pollutants present a risk to public health, welfare, or the environment.

These are standard (i.e., typically applicable) operating procedures which may be varied or changed as required, dependent upon site conditions, equipment limitations or limitations imposed by the procedure. In all instances, the ultimate procedures employed should be documented and associated with the final report.

Mention of trade names or commercial products does not constitute U.S. Environmental Protection Agency (EPA) endorsement or recommendation for use.

2.0 METHOD SUMMARY

Soil samples may be collected using a variety of methods and equipment. The methods and equipment used are dependent on the depth of the desired sample, the type of sample required (disturbed vs. undisturbed), and the soil type. Near-surface soils may be easily sampled using a spade, trowel, and scoop. Sampling at greater depths may be performed using a hand auger, continuous flight auger, a trier, a split-spoon, or, if required, a backhoe.

3.0 SAMPLE PRESERVATION, CONTAINERS, HANDLING, AND STORAGE

Chemical preservation of solids is not generally recommended. Samples should, however, be cooled and protected from sunlight to minimize any potential reaction.

4.0 INTERFERENCES AND POTENTIAL PROBLEMS

There are two primary interferences or potential problems associated with soil sampling. These include cross contamination of samples and improper sample collection. Cross contamination problems can be eliminated or minimized through the use of dedicated sampling equipment. If this is not possible or practical, then decontamination of sampling equipment is necessary. Improper sample collection can involve using contaminated equipment, disturbance of the matrix resulting in compaction of the sample or inadequate homogenization of the samples where required, resulting in variable, non-representative results.

5.0 EQUIPMENT/APPARATUS

Soil sampling equipment includes the following:

- C Sampling plan
- C Maps/plot plan
- C Safety equipment, as specified in the Health and Safety Plan
- C Survey equipment
- C Tape measure
- C Survey stakes or flags
- C Camera and film
- C Stainless steel, plastic, or other appropriate homogenization bucket, bowl or pan
- C Appropriate size sample containers
- C Ziplock plastic bags
- C Logbook
- C Labels
- C Chain of Custody records and seals
- C Field data sheets
- C Cooler(s)
- C Ice
- C Vermiculite
- C Decontamination supplies/equipment
- C Canvas or plastic sheet
- C Spade or shovel

- C Spatula
- C Scoop
- C Plastic or stainless steel spoons
- C Trowel
- C Continuous flight (screw) auger
- C Bucket auger
- C Post hole auger
- C Extension rods
- C T-handle
- C Sampling trier
- C Thin wall tube sampler
- C Split spoons
- C Vehimeyer soil sampler outfit
 - Tubes
 - Points
 - Drive head
 - Drop hammer
 - Puller jack and grip
- C Backhoe

6.0 REAGENTS

Reagents are not used for the preservation of soil samples. Decontamination solutions are specified in the Sampling Equipment Decontamination SOP and the site specific work plan.

7.0 PROCEDURES

7.1 Preparation

1. Determine the extent of the sampling effort, the sampling methods to be employed, and the types and amounts of equipment and supplies required.
2. Obtain necessary sampling and monitoring equipment.
3. Decontaminate or pre-clean equipment, and ensure that it is in working order.
4. Prepare schedules, and coordinate with staff, client, and regulatory agencies, if appropriate.
5. Perform a general site survey prior to site entry in accordance with the site specific Health and Safety Plan.
6. Use stakes, flagging, or buoys to identify and mark all sampling locations. Specific site

factors, including extent and nature of contaminant should be considered when selecting sample location. If required, the proposed locations may be adjusted based on site access, property boundaries, and surface obstructions. All staked locations will be utility-cleared by the property owner prior to soil sampling.

7.2 Sample Collection

7.2.1 Surface Soil Samples

Collection of samples from near-surface soil can be accomplished with tools such as spades, shovels, trowels, and scoops. Surface material can be removed to the required depth with this equipment, then a stainless steel or plastic scoop can be used to collect the sample.

This method can be used in most soil types but is limited to sampling near surface areas. Accurate, representative samples can be collected with this procedure depending on the care and precision demonstrated by the sample team member. A stainless steel scoop, lab spoon, or plastic spoon will suffice in most other applications. The use of a flat, pointed mason trowel to cut a block of the desired soil can be helpful when undisturbed profiles are required. Care should be exercised to avoid use of devices plated with chrome or other materials. Plating is particularly common with garden implements such as potting trowels.

The following procedure is used to collect surface soil samples:

1. Carefully remove the top layer of soil or debris to the desired sample depth with a pre-cleaned spade.
2. Using a pre-cleaned, stainless steel scoop, plastic spoon, or trowel, remove and discard a thin layer of soil from the area which came in contact with the spade.
3. If volatile organic analysis is to be performed, transfer the sample directly into an appropriate, labeled sample container with a stainless steel lab spoon, or equivalent and secure the cap tightly. Place the remainder of the sample into a stainless steel, plastic, or

other appropriate homogenization container, and mix thoroughly to obtain a homogenous sample representative of the entire sampling interval. Then, either place the sample into appropriate, labeled containers and secure the caps tightly; or, if composite samples are to be collected, place a sample from another sampling interval or location into the homogenization container and mix thoroughly. When compositing is complete, place the sample into appropriate, labeled containers and secure the caps tightly.

7.2.2 Sampling at Depth with Augers and Thin Wall Tube Samplers

This system consists of an auger, or a thin-wall tube sampler, a series of extensions, and a "T" handle (Figure 1, Appendix A). The auger is used to bore a hole to a desired sampling depth, and is then withdrawn. The sample may be collected directly from the auger. If a core sample is to be collected, the auger tip is then replaced with a thin wall tube sampler. The system is then lowered down the borehole, and driven into the soil to the completion depth. The system is withdrawn and the core is collected from the thin wall tube sampler.

Several types of augers are available; these include: bucket type, continuous flight (screw), and post-hole augers. Bucket type augers are better for direct sample recovery since they provide a large volume of sample in a short time. When continuous flight augers are used, the sample can be collected directly from the flights. The continuous flight augers are satisfactory for use when a composite of the complete soil column is desired. Post-hole augers have limited utility for sample collection as they are designed to cut through fibrous, rooted, swampy soil and cannot be used below a depth of three feet.

The following procedure will be used for collecting soil samples with the auger:

1. Attach the auger bit to a drill rod extension, and attach the "T" handle to the drill rod.
2. Clear the area to be sampled of any surface debris (e.g., twigs, rocks, litter). It may be advisable to remove the first three to six inches of surface soil for an area approximately six inches in radius around the

drilling location.

3. Begin augering, periodically removing and depositing accumulated soils onto a plastic sheet spread near the hole. This prevents accidental brushing of loose material back down the borehole when removing the auger or adding drill rods. It also facilitates refilling the hole, and avoids possible contamination of the surrounding area.
4. After reaching the desired depth, slowly and carefully remove the auger from boring. When sampling directly from the auger, collect the sample after the auger is removed from the boring and proceed to Step 10.
5. Remove auger tip from drill rods and replace with a pre-cleaned thin wall tube sampler. Install the proper cutting tip.
6. Carefully lower the tube sampler down the borehole. Gradually force the tube sampler into soil. Care should be taken to avoid scraping the borehole sides. Avoid hammering the drill rods to facilitate coring as the vibrations may cause the boring walls to collapse.
7. Remove the tube sampler, and unscrew the drill rods.
8. Remove the cutting tip and the core from the device.
9. Discard the top of the core (approximately 1 inch), as this possibly represents material collected before penetration of the layer of concern. Place the remaining core into the appropriate labeled sample container. Sample homogenization is not required.
10. If volatile organic analysis is to be performed, transfer the sample into an appropriate, labeled sample container with a stainless steel lab spoon, or equivalent and secure the cap tightly. Place the remainder of the sample into a stainless steel, plastic, or other appropriate homogenization container, and mix thoroughly to obtain a homogenous sample representative of the entire sampling interval. Then, either place the sample into appropriate, labeled containers and secure the

caps tightly; or, if composite samples are to be collected, place a sample from another sampling interval into the homogenization container and mix thoroughly.

When compositing is complete, place the sample into appropriate, labeled containers and secure the caps tightly.

11. If another sample is to be collected in the same hole, but at a greater depth, reattach the auger bit to the drill and assembly, and follow steps 3 through 11, making sure to decontaminate the auger and tube sampler between samples.
12. Abandon the hole according to applicable State regulations. Generally, shallow holes can simply be backfilled with the removed soil material.

7.2.3 Sampling at Depth with a Trier

The system consists of a trier, and a "T" handle. The auger is driven into the soil to be sampled and used to extract a core sample from the appropriate depth.

The following procedure will be used to collect soil samples with a sampling trier:

1. Insert the trier (Figure 2, Appendix A) into the material to be sampled at a 0° to 45° angle from horizontal. This orientation minimizes the spillage of sample.
2. Rotate the trier once or twice to cut a core of material.
3. Slowly withdraw the trier, making sure that the slot is facing upward.
4. If volatile organic analysis is to be performed, transfer the sample into an appropriate, labeled sample container with a stainless steel lab spoon, or equivalent and secure the cap tightly. Place the remainder of the sample into a stainless steel, plastic, or other appropriate homogenization container, and mix thoroughly to obtain a homogenous sample representative of the entire sampling interval. Then, either place the sample into appropriate, labeled containers and secure the

caps tightly; or, if composite samples are to be collected, place a sample from another sampling interval into the homogenization container and mix thoroughly. When compositing is complete, place the sample into appropriate, labeled containers and secure the caps tightly.

7.2.4 Sampling at Depth with a Split Spoon (Barrel) Sampler

The procedure for split spoon sampling describes the collection and extraction of undisturbed soil cores of 18 or 24 inches in length. A series of consecutive cores may be extracted with a split spoon sampler to give a complete soil column profile, or an auger may be used to drill down to the desired depth for sampling. The split spoon is then driven to its sampling depth through the bottom of the augured hole and the core extracted.

When split spoon sampling is performed to gain geologic information, all work should be performed in accordance with ASTM D 1586-67 (reapproved 1974).

The following procedures will be used for collecting soil samples with a split spoon:

1. Assemble the sampler by aligning both sides of barrel and then screwing the drive shoe on the bottom and the head piece on top.
2. Place the sampler in a perpendicular position on the sample material.
3. Using a well ring, drive the tube. Do not drive past the bottom of the head piece or compression of the sample will result.
4. Record in the site logbook or on field data sheets the length of the tube used to penetrate the material being sampled, and the number of blows required to obtain this depth.
5. Withdraw the sampler, and open by unscrewing the bit and head and splitting the barrel. The amount of recovery and soil type should be recorded on the boring log. If a split sample is desired, a cleaned, stainless steel knife should be used to divide the tube contents in half, longitudinally. This sampler

is typically available in 2 and 3 1/2 inch diameters. However, in order to obtain the required sample volume, use of a larger barrel may be required.

6. Without disturbing the core, transfer it to appropriate labeled sample container(s) and seal tightly.

7.2.5 Test Pit/Trench Excavation

These relatively large excavations are used to remove sections of soil, when detailed examination of soil characteristics (horizontal, structure, color, etc.) are required. It is the least cost effective sampling method due to the relatively high cost of backhoe operation.

The following procedures will be used for collecting soil samples from test pit/trench excavations:

1. Prior to any excavation with a backhoe, it is important to ensure that all sampling locations are clear of utility lines, subsurface pipes and poles (subsurface as well as above surface).
2. Using the backhoe, a trench is dug to approximately three feet in width and approximately one foot below the cleared sampling location. Place excavated soils on plastic sheets. Trenches greater than five feet deep must be sloped or protected by a shoring system, as required by OSHA regulations.
3. A shovel is used to remove a one to two inch layer of soil from the vertical face of the pit where sampling is to be done.
4. Samples are taken using a trowel, scoop, or coring device at the desired intervals. Be sure to scrape the vertical face at the point of sampling to remove any soil that may have fallen from above, and to expose fresh soil for sampling. In many instances, samples can be collected directly from the backhoe bucket.
5. If volatile organic analysis is to be performed, transfer the sample into an appropriate, labeled sample container with a

stainless steel lab spoon, or equivalent and secure the cap tightly. Place the remainder of the sample into a stainless steel, plastic, or other appropriate homogenization container, and mix thoroughly to obtain a homogenous sample representative of the entire sampling interval. Then, either place the sample into appropriate, labeled containers and secure the caps tightly; or, if composite samples are to be collected, place a sample from another sampling interval into the homogenization container and mix thoroughly. When compositing is complete, place the sample into appropriate, labeled containers and secure the caps tightly.

6. Abandon the pit or excavation according to applicable state regulations. Generally, shallow excavations can simply be backfilled with the removed soil material.

8.0 CALCULATIONS

This section is not applicable to this SOP.

9.0 QUALITY ASSURANCE/ QUALITY CONTROL

There are no specific quality assurance (QA) activities which apply to the implementation of these procedures. However, the following QA procedures apply:

1. All data must be documented on field data sheets or within site logbooks.
2. All instrumentation must be operated in accordance with operating instructions as supplied by the manufacturer, unless otherwise specified in the work plan. Equipment checkout and calibration activities must occur prior to sampling/operation, and they must be documented.

10.0 DATA VALIDATION

This section is not applicable to this SOP.

11.0 HEALTH AND SAFETY

When working with potentially hazardous materials, follow U.S. EPA, OHSA and corporate health and safety procedures.

12.0 REFERENCES

Mason, B.J., Preparation of Soil Sampling Protocol: Technique and Strategies. 1983 EPA-600/4-83-020.

Barth, D.S. and B.J. Mason, Soil Sampling Quality Assurance User's Guide. 1984 EPA-600/4-84-043.

U.S. EPA. Characterization of Hazardous Waste Sites - A Methods Manual: Volume II. Available Sampling Methods, Second Edition. 1984 EPA-600/4-84-076.

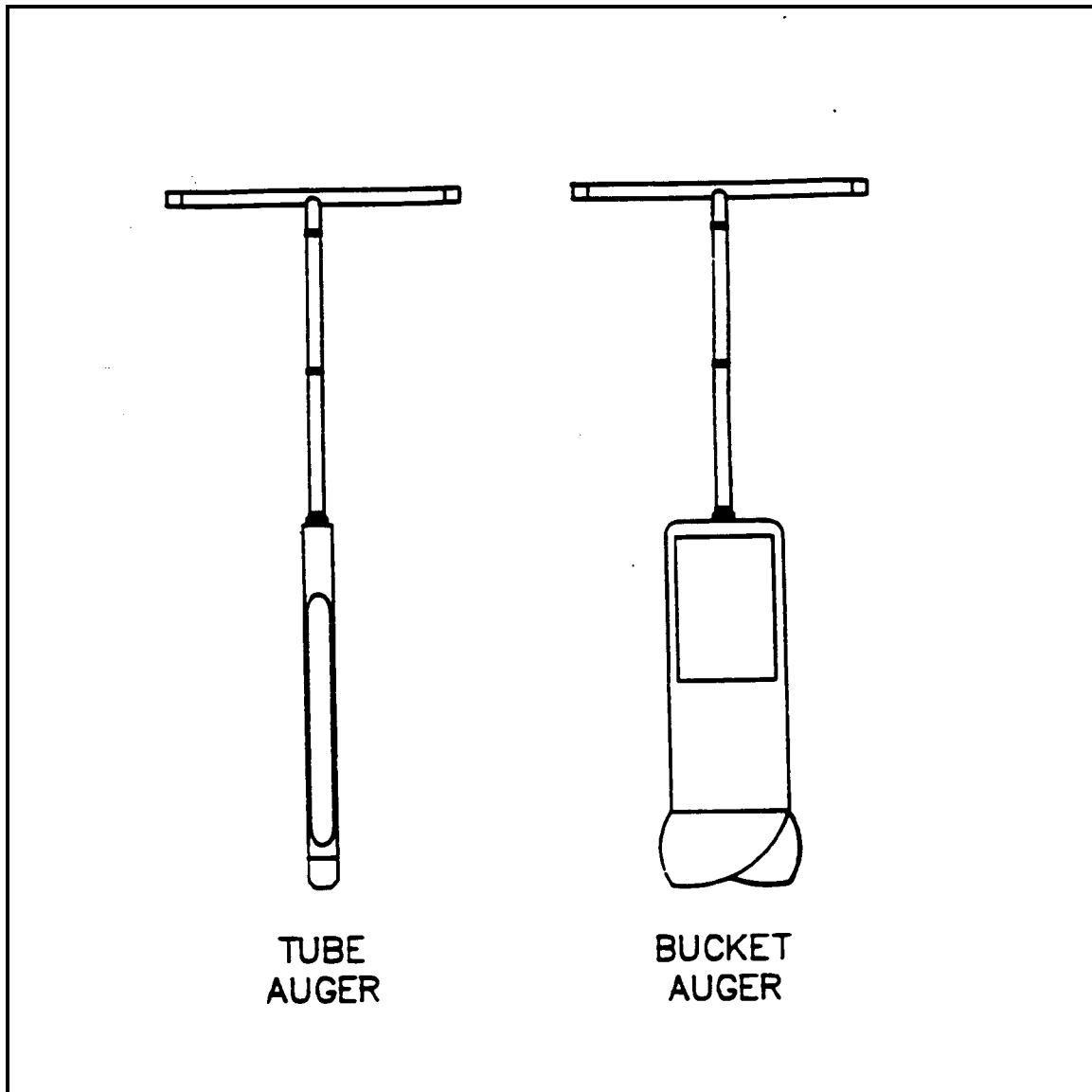
de Vera, E.R., B.P. Simmons, R.D. Stephen, and D.L. Storm. Samplers and Sampling Procedures for Hazardous Waste Streams. 1980 EPA-600/2-80-018.

ASTM D 1586-67 (reapproved 1974), ASTM Committee on Standards, Philadelphia, PA.

APPENDIX A

Figures

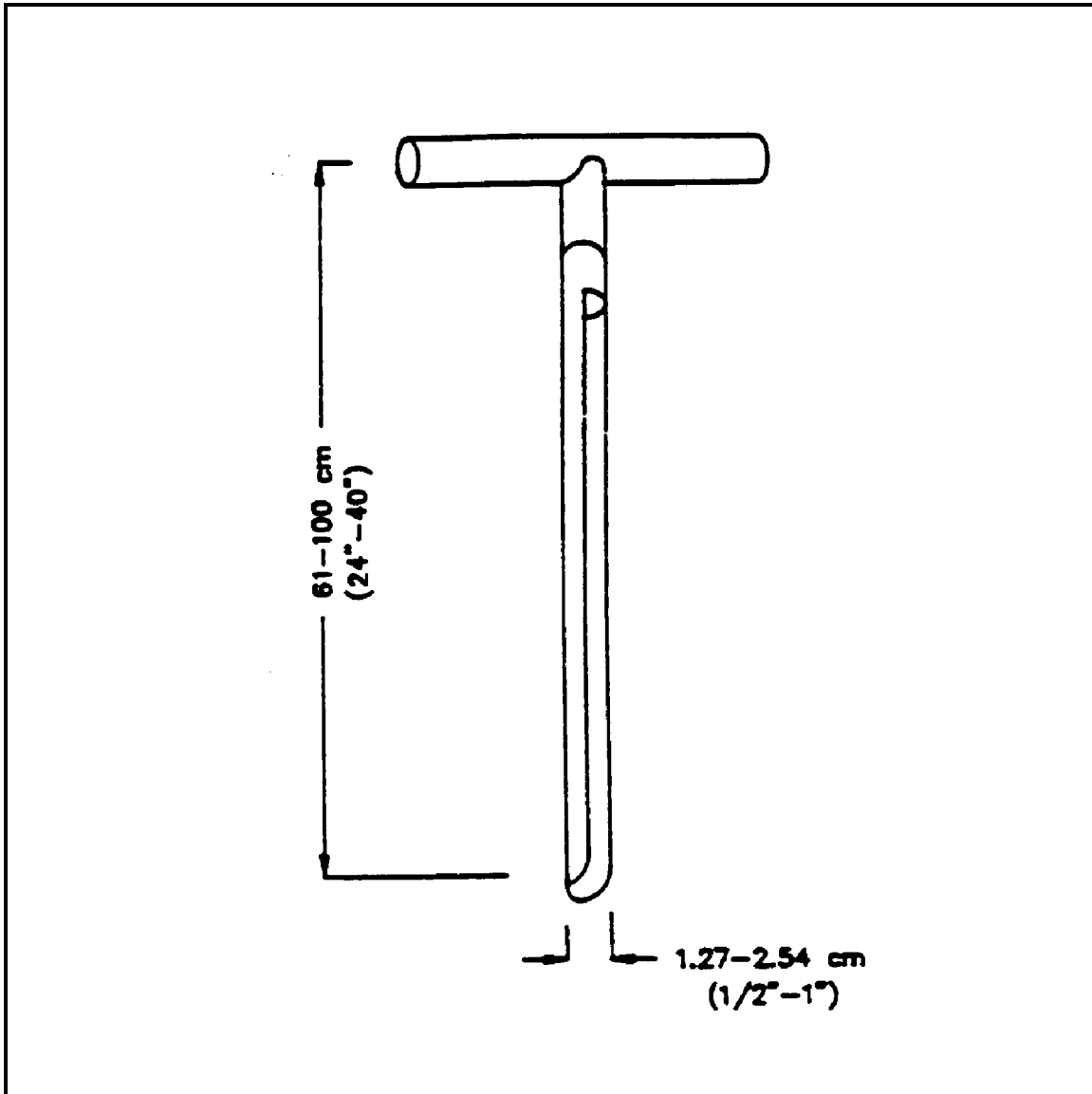
FIGURE 1. Sampling Augers



APPENDIX A (Cont'd)

Figures

FIGURE 2. Sampling Trier





GROUNDWATER WELL SAMPLING

SOP#: 2007
DATE: 01/26/95
REV. #: 0.0

1.0 SCOPE AND APPLICATION

The objective of this standard operating procedure (SOP) is to provide general reference information on sampling of ground water wells. This guideline is primarily concerned with the collection of water samples from the saturated zone of the subsurface. Every effort must be made to ensure that the sample is representative of the particular zone of water being sampled. These procedures are designed to be used in conjunction with analyses for the most common types of ground water contaminants (e.g., volatile and semi-volatile organic compounds, pesticides, metals, biological parameters).

These are standard (i.e., typically applicable) operating procedures which may be varied or changed as required, dependent upon site conditions, equipment limitations or limitations imposed by the procedure. In all instances, the ultimate procedures employed should be documented and associated with the final report.

Mention of trade names or commercial products does not constitute U.S. Environmental Protection Agency (EPA) endorsement or recommendation for use.

2.0 METHOD SUMMARY

In order to obtain a representative groundwater sample for chemical analysis it is important to remove stagnant water in the well casing and the water immediately adjacent to the well before collection of the sample. This may be achieved with one of a number of instruments. The most common of these are the bailer, submersible pump, non-contact gas bladder pump, inertia pump and suction pump. At a minimum, three well volumes should be purged, if possible. Equipment must be decontaminated prior to use and between wells. Once purging is completed and the correct laboratory-cleaned sample containers have been prepared, sampling may proceed. Sampling may be conducted with any of the above instruments,

and need not be the same as the device used for purging. Care should be taken when choosing the sampling device as some will affect the integrity of the sample. Sampling should occur in a progression from the least to most contaminated well, if this information is known.

The growing concern over the past several years over low levels of volatile organic compounds in water supplies has led to the development of highly sophisticated analytical methods that can provide detection limits at part per trillion levels. While the laboratory methods are extremely sensitive, well controlled and quality assured, they cannot compensate for a poorly collected sample. The collection of a sample should be as sensitive, highly developed and quality assured as the analytical procedures.

3.0 SAMPLE PRESERVATION, CONTAINERS, HANDLING, AND STORAGE

The type of analysis for which a sample is being collected determines the type of bottle, preservative, holding time, and filtering requirements. Samples should be collected directly from the sampling device into appropriate laboratory cleaned containers. Check that a Teflon liner is present in the cap, if required. Attach a sample identification label. Complete a field data sheet, a chain of custody form, and record all pertinent data in the site logbook.

Samples shall be appropriately preserved, labelled, logged, and placed in a cooler to be maintained at 4EC. Samples must be shipped well before the holding time is up and ideally should be shipped within 24 hours of sample collection. It is imperative that samples be shipped or delivered daily to the analytical laboratory in order to maximize the time available for the laboratory to perform the analyses. The bottles should be shipped with adequate packing and cooling to ensure that they arrive intact.

Sample retrieval systems suitable for the valid collection of volatile organic samples are: positive displacement bladder pumps, gear driven submersible pumps, syringe samplers and bailers (Barcelona, 1984; Nielsen, 1985). Field conditions and other constraints will limit the choice of appropriate systems. The focus of concern must remain to provide a valid sample for analysis, one which has been subjected to the least amount of turbulence possible.

Treatment of the sample with sodium thiosulfate preservative is required only if there is residual chlorine in the water that could cause free radical chlorination and change the identity of the original contaminants. It should not be used if there is no chlorine in the water.

Holding time for volatiles analysis is seven days. It is imperative that the sample be shipped or delivered daily to the analytical laboratory. The bottles must be shipped on their sides to aid in maintaining the airtight seal during shipment, with adequate packing and cooling to ensure that they arrive intact.

For collection of volatile organic samples, refer to the work plan to ensure that 40 mL glass sample vials with Teflon lined septa are ordered and in sufficient numbers. Check sampling supplies; field kit for chlorine, preservatives, Parafilm, foam sleeves and coolers. Due to the extreme trace levels at which volatile organics are detectable, cross contamination and introduction of contaminants must be avoided. Trip blanks are incorporated into the shipment package to provide a check against cross contamination.

4.0 INTERFERENCES AND POTENTIAL PROBLEMS

4.1 General

The primary goal in performing ground water sampling is to obtain a representative sample of the ground water body. Analysis can be compromised by field personnel in two primary ways: (1) taking an unrepresentative sample, or (2) by incorrect handling of the sample. There are numerous ways of introducing foreign contaminants into a sample, and these must be avoided by following strict sampling procedures and utilizing trained field personnel.

4.2 Purging

In a nonpumping well, there will be little or no vertical mixing of the water, and stratification will occur. The well water in the screened section will mix with the ground water due to normal flow patterns, but the well water above the screened section will remain isolated, become stagnant, and may lack the contaminants representative of the ground water. Persons sampling should realize that stagnant water may contain foreign material inadvertently or deliberately introduced from the surface, resulting in an unrepresentative sample. To safeguard against collecting nonrepresentative stagnant water, the following guidelines and techniques should be adhered to during sampling:

1. As a general rule, all monitor wells should be pumped or bailed prior to sampling. Purge water should be containerized on site or handled as specified in the site specific project plan. Evacuation of a minimum of one volume of water in the well casing, and preferably three to five volumes, is recommended for a representative sample. In a high-yielding ground water formation and where there is no stagnant water in the well above the screened section, evacuation prior to sample withdrawal is not as critical. However, in all cases where the monitoring data is to be used for enforcement actions, evacuation is recommended.
2. When purging with a pump (not a bailer), the pump should be set at the screened interval, or if the well is an open-rock well, it should be set at the same depth the sample will be collected. When sampling a screened well, the sample should also be collected from the same depth the pump was set at.
3. The well should be sampled as soon as possible after purging.
4. Analytical parameters typically dictate whether the sample should be collected through the purging device, or through a separate sampling instrument.
5. For wells that can be pumped or bailed to dryness with the equipment being used, the well should be evacuated and allowed to

recover prior to collecting a sample. If the recovery rate is fairly rapid and time allows, evacuation of more than one volume of water is preferred. If recovery is slow, sample the well upon recovery after one evacuation.

6. A non-representative sample can also result from excessive pre-pumping of the monitoring well. Stratification of the leachate concentration in the ground water formation may occur, or heavier-than-water compounds may sink to the lower portions of the aquifer. Excessive pumping can dilute or increase the contaminant concentrations from what is representative of the sampling point of interest.

4.3 Materials

Materials of construction for samplers and evacuation equipment (bladders, pump, bailers, tubing, etc.) should be limited to stainless steel, Teflon^R, and glass in areas where concentrations are expected to be at or near the detection limit. The tendency of organics to leach into and out of many materials make the selection of materials critical for trace analyses. The use of plastics, such as PVC or polyethylene, should be avoided when analyzing for organics. However, PVC may be used for evacuation equipment as it will not come in contact with the sample, and in highly contaminated wells, disposable equipment (i.e., polypropylene bailers) may be appropriate to avoid cross-contamination.

Materials of construction (bladders/ pumps, bailers, tubing, etc.) suitable for collecting and handling Volatile Organic Samples should be limited to stainless steel, Teflon and glass in areas which detection limit range concentrations are expected. The tendency of organics to leach into and out of many materials, make the selection of materials critical for these trace analyses. The use of plastics, e.g., PVC etc., should be avoided. There are numerous ways of introducing foreign contaminants into a sample, and these must be avoided by following strict sampling procedures and utilization of trained personnel.

4.4 Advantages/Disadvantages of Certain Equipment

4.4.1 Bailers

Advantages

- C Only practical limitations on size and materials
- C No power source needed
- C Portable
- C Inexpensive, so it can be dedicated and hung in a well, thereby reducing the chances of cross contamination
- C Minimal outgassing of volatile organics while sample is in bailer
- C Readily available
- C Removes stagnant water first
- C Rapid, simple method for removing small volumes of purge water

Disadvantages

- C Time-consuming to flush a large well of stagnant water
- C Transfer of sample may cause aeration
- C Stoppers at the bottom of the bailer usually leak thus the bailer must be brought to the surface rapidly
- C If the bailer is allowed to hit the bottom of the well boring, gravel can displace the ball valve not allowing the bailer to hold water

4.4.2 Submersible Pumps

Advantages

- C Portable and can be transported to several wells
- C Depending upon the size of the pump and the pumping depths, relatively high pumping rates are possible
- C Generally very reliable and does not require priming

Disadvantages

- C Potential for effects on analysis of trace organics
- C Heavy and cumbersome to deal with, particularly in deeper wells
- C Expensive
- C Power source needed
- C Sediment in water may cause problems with the pumps
- C Impractical in low yielding or shallow wells

4.4.3 Non-Contact Gas Bladder Pumps

Advantages

- C Maintains integrity of sample
- C Easy to use
- C Can sample from discrete locations within the monitor well

Disadvantages

- C Difficulty in cleaning, though dedicated tubing and bladder may be used
- C Only useful to about 100 feet
- C Supply of gas for operation, gas bottles and/or compressors are often difficult to obtain and are cumbersome
- C Relatively low pumping rates
- C Requires air compressor or pressurized gas source and control box

4.4.4 Suction Pumps

Advantages

- C Portable, inexpensive, and readily available

Disadvantages

- C Restricted to areas with water levels within 20 to 25 feet of the ground surface
- C Vacuum can cause loss of dissolved gasses and volatile organics
- C Pump must be primed and vacuum is often difficult to maintain during initial stages of pumping

4.4.5 Inertia Pumps

Advantages

- C Portable, inexpensive, and readily available
- C Offers a rapid method for purging relatively shallow wells

Disadvantages

- C Restricted to areas with water levels within 70 feet of the ground surface
- C May be time consuming to purge wells with these manual pumps
- C Labor intensive
- C WaTerra pumps are only effective in 2-inch diameter wells

5.0 EQUIPMENT APPARATUS

5.1 Equipment Checklist

5.1.1 General

- C Water level indicator
 - electric sounder
 - steel tape
 - transducer
 - reflection sounder
 - airline
- C Depth sounder
- C Appropriate keys for well cap locks
- C Steel brush
- C HNU or OVA (whichever is most appropriate)
- C Logbook
- C Calculator
- C Field data sheets and samples labels

- C Chain of custody records and seals
- C Sample containers
- C Engineer's rule
- C Sharp knife (locking blade)
- C Tool box (to include at least: screwdrivers, pliers, hacksaw, hammer, flashlight, adjustable wrench)
- C Leather work gloves
- C Appropriate Health & Safety gear
- C 5-gallon pail
- C Plastic sheeting
- C Shipping containers
- C Packing materials
- C Bolt cutters
- C Ziploc plastic bags
- C Containers for evacuation liquids
- C Decontamination solutions
- C Tap water
- C Non phosphate soap
- C Several brushes
- C Pails or tubs
- C Aluminum foil
- C Garden sprayer
- C Preservatives
- C Distilled or deionized water
- C Fire extinguisher (if using a generator for your power source)

5.1.2 Bailers

- C Clean, decontaminated bailers of appropriate size and construction material
- C Nylon line, enough to dedicate to each well
- C Teflon coated bailer wire
- C Sharp knife
- C Aluminum foil (to wrap clean bailers)
- C Five gallon bucket

5.1.3 Submersible Pump

- C Pump(s)
- C Generator (110, 120, or 240 volt) or 12 volt battery if inaccessible to field vehicle - amp meter is useful
- C 1" black PVC coil tubing - enough to dedicate to each well
- C Hose clamps
- C Safety cable
- C Tool box supplement
 - pipe wrenches

- wire strippers
- electrical tape
- heat shrink
- hose connectors
- Teflon tape

- C Winch, pulley or hoist
- C Gasoline for generator/gas can
- C Flow meter with gate valve
- C 1" nipples and various plumbing (i.e., pipe connectors)
- C Control box (if necessary)

5.1.4 Non-Gas Contact Bladder Pump

- C Non-gas contact bladder pump
- C Compressor or nitrogen gas tank
- C Batteries and charger
- C Teflon tubing - enough to dedicate to each well
- C Swagelock fitting
- C Toolbox supplements - same as submersible pump
- C Control box (if necessary)

5.1.5 Suction Pump

- C Pump
- C 1" black PVC coil tubing - enough to dedicate to each well
- C Gasoline - if required
- C Toolbox
- C Plumbing fittings
- C Flow meter with gate valve

5.1.6 Inertia Pump

- C Pump assembly (WaTerra pump, piston pump)
- C Five gallon bucket

6.0 REAGENTS

Reagents may be utilized for preservation of samples and for decontamination of sampling equipment. The preservatives required are specified by the analysis to be performed. Decontamination solutions are specified in ERT SOP #2006, Sampling Equipment Decontamination.

7.0 PROCEDURE

7.1 Preparation

1. Determine the extent of the sampling effort, the sampling methods to be employed, and the types and amounts of equipment and supplies needed (i.e., diameter and depth of wells to be sampled).
2. Obtain necessary sampling and monitoring equipment, appropriate to type of contaminant being investigated. For collection of volatile organic samples, refer to the work plan to ensure that 40 mL glass sample vials with Teflon lined septa are ordered and in sufficient numbers. Check sampling supplies; field kit for chlorine, preservatives, Parafilm, foam sleeves and coolers. Due to extreme trace levels at which volatile organics are detectable, cross contamination and introduction of contaminants must be avoided. Trip blanks are incorporated into the shipment package to provide a check against cross contamination.
3. Decontaminate or preclean equipment, and ensure that it is in working order.
4. Prepare scheduling and coordinate with staff, clients, and regulatory agency, if appropriate.
5. Perform a general site survey prior to site entry in accordance with the site specific Health and Safety Plan.
6. Identify and mark all sampling locations.

7.2 Field Preparation

1. Start at the least contaminated well, if known.
2. Lay plastic sheeting around the well to minimize likelihood of contamination of equipment from soil adjacent to the well.
3. Remove locking well cap, note location, time of day, and date in field notebook or appropriate log form.
4. Remove well casing cap.

5. Screen headspace of well with an appropriate monitoring instrument to determine the presence of volatile organic compounds and record in site logbook.
6. Lower water level measuring device or equivalent (i.e., permanently installed transducers or airline) into well until water surface is encountered.
7. Measure distance from water surface to reference measuring point on well casing or protective barrier post and record in site logbook. Alternatively, if no reference point, note that water level measurement is from top of steel casing, top of PVC riser pipe, from ground surface, or some other position on the well head.

If floating organics are of concern, this can be determined by measuring the water level with an oil/water interface probe which measures floating organics.
8. Measure total depth of well (at least twice to confirm measurement) and record in site logbook or on field data sheet.
9. Calculate the volume of water in the well and the volume to be purged using the calculations in Section 8.0.
10. Select the appropriate purging and sampling equipment.
11. If residual chlorine is suspected, use the Hach Field Test Kit for chlorine to determine if there is residual chlorine in the water to be sampled. If there is, treat the sample vial with a crystal of sodium thiosulfate prior to sample collection.

7.3 Purging

The amount of flushing a well receives prior to sample collection depends on the intent of the monitoring program as well as the hydrogeologic conditions. Programs where overall quality determination of water resources are involved may require long pumping periods to obtain a sample that is representative of a large volume of that aquifer. The pumped volume can be determined prior to sampling so that the sample is

a collected after a known volume of the water is evacuated from the aquifer, or the well can be pumped until the stabilization of parameters such as temperature, electrical conductance, pH, or turbidity has occurred.

However, monitoring for defining a contaminant plume requires a representative sample of a small volume of the aquifer. These circumstances require that the well be pumped enough to remove the stagnant water but not enough to induce flow from other areas. Generally, three well volumes are considered effective, or calculations can be made to determine, on the basis of the aquifer parameters and well dimensions, the appropriate volume to remove prior to sampling.

During purging, water level measurements may be taken regularly at 15-30 second intervals. This data may be used to compute aquifer transmissivity and other hydraulic characteristics. The following well evacuation devices are most commonly used. Other evacuation devices are available, but have been omitted in this discussion due to their limited use.

7.3.1 Bailers

Bailers are the simplest purging device used and have many advantages. They generally consist of a rigid length of tube, usually with a ball check-valve at the bottom. A line is used to lower the bailer into the well and retrieve a volume of water. The three most common types of bailer are PVC, Teflon, and stainless steel.

This manual method of purging is best suited to shallow or narrow diameter wells. For deep, larger diameter wells which require evacuation of large volumes of water, other mechanical devices may be more appropriate.

7.3.1.1 Operation

Equipment needed will include a clean decontaminated bailer, Teflon or nylon line, a sharp knife, and plastic sheeting.

1. Determine the volume of water to be purged as described in 8.0, calculations.
2. Lay plastic sheeting around the well to prevent contamination of the bailer line with

foreign materials.

3. Attach the line to the bailer and slowly lower until the bailer is completely submerged, being careful not to drop the bailer to the water, causing turbulence and the possible loss of volatile organic contaminants.
4. Pull bailer out ensuring that the line either falls onto a clean area of plastic sheeting or never touches the ground.
5. Empty the bailer into a pail until full to determine the number of bails necessary to achieve the required purge volume.
6. Thereafter, pour the water into a container and dispose of purge waters as specified in the site specific sampling plan.

7.3.2 Submersible Pumps

The use of submersible pumps for sample collection is permissible provided they are constructed of suitably noncontaminating materials. The chief drawback, however, is the difficulty avoiding cross-contamination between wells. Although some units can be disassembled easily to allow surfaces contacted by contaminants to be cleaned, field decontamination may be difficult and require solvents that can affect sample analysis. The use of submersible pumps in multiple well-sampling programs, therefore, should be carefully considered against other sampling mechanisms (bailers, bladder pumps). In most cases, a sample can be collected by bailer after purging with a submersible pump, however, submersible pumps may be the only practical sampling device for extremely deep wells (greater than 300 feet of water). Under those conditions, dedicated pump systems should be installed to eliminate the potential for cross-contamination of well samples.

Submersible pumps generally use one of two types of power supplies, either electric or compressed gas or air. Electric powered pumps can run off a 12 volt DC rechargeable battery, or a 110 or 220 volt AC power supply. Those units powered by compressed air normally use a small electric or gas-powered air compressor. They may also utilize compressed gas (i.e., nitrogen) from bottles. Different size pumps are available for different depth or diameter monitoring wells.

7.3.2.1 Operation

1. Determine the volume of water to be purged as described in 8.0 Calculations.
2. Lay plastic sheeting around the well to prevent contamination of pumps, hoses or lines with foreign materials.
3. Assemble pump, hoses and safety cable, and lower the pump into the well. Make sure the pump is deep enough so all the water is not evacuated. (Running the pump without water may cause damage.)
4. Attach flow meter to the outlet hose to measure the volume of water purged.
5. Use a ground fault circuit interrupter (GFCI) or ground the generator to avoid possible electric shock.
6. Attach power supply, and purge the well until the specified volume of water has been evacuated (or until field parameters, such as temperature, pH, conductivity, etc, have stabilized). Do not allow the pump to run dry. If the pumping rate exceeds the well recharge rate, lower the pump further into the well, and continue pumping.
7. Collect and dispose of purge waters as specified in the site specific sampling plan.

7.3.3 Non-Contact Gas Bladder Pumps

For this procedure, an all stainless-steel and Teflon Middleburg-squeeze bladder pump (e.g., IEA, TIMCO, Well Wizard, Geoguard, and others) is used to provide the least amount of material interference to the sample (Barcelona, 1985). Water comes into contact with the inside of the bladder (Teflon) and the sample tubing, also Teflon, that may be dedicated to each well. Some wells may have permanently installed bladder pumps, (i.e., Well Wizard, Geoguard), that will be used to sample for all parameters.

7.3.3.1 Operation

1. Assemble Teflon tubing, pump and charged control box.
2. Procedure for purging with a bladder pump is

the same as for a submersible pump (Section 7.3.2.1).

3. Be sure to adjust flow rate to prevent violent jolting of the hose as sample is drawn in.

7.3.4 Suction Pumps

There are many different types of suction pumps. They include: centrifugal, peristaltic and diaphragm. Diaphragm pumps can be used for well evacuation at a fast pumping rate and sampling at a low pumping rate. The peristaltic pump is a low volume pump that uses rollers to squeeze the flexible tubing thereby creating suction. This tubing can be dedicated to a well to prevent cross contamination. Peristaltic pumps, however, require a power source.

7.3.4.1 Operation

1. Assembly of the pump, tubing, and power source if necessary.
2. Procedure for purging with a suction pump is exactly the same as for a submersible pump (Section 7.3.2.1).

7.3.5 Inertia Pumps

Inertia pumps such as the WaTerra pump and piston pump, are manually operated. They are most appropriate to use when wells are too deep to bail by hand, or too shallow or narrow (or inaccessible) to warrant an automatic (submersible, etc.) pump. These pumps are made of plastic and may be either decontaminated or discarded.

7.3.5.1 Operation

1. Determine the volume of water to be purged as described in 8.0, Calculations.
2. Lay plastic sheeting around the well to prevent contamination of pumps or hoses with foreign materials.
3. Assemble pump and lower to the appropriate depth in the well.
4. Begin pumping manually, discharging water into a 5 gallon bucket (or other graduated vessel). Purge until specified volume of water has been evacuated (or until field parameters such as temperature, pH,

conductivity, etc. have stabilized).

5. Collect and dispose of purge waters as specified in the site specific project plan.

7.4 Sampling

Sample withdrawal methods require the use of pumps, compressed air, bailers, and samplers. Ideally, purging and sample withdrawal equipment should be completely inert, economical to manufacture, easily cleaned, sterilized, reusable, able to operate at remote sites in the absence of power resources, and capable of delivering variable rates for sample collection.

There are several factors to take into consideration when choosing a sampling device. Care should be taken when reviewing the advantages or disadvantages of any one device. It may be appropriate to use a different device to sample than that which was used to purge. The most common example of this is the use of a submersible pump to purge and a bailer to sample.

7.4.1 Bailers

The positive-displacement volatile sampling bailer is perhaps the most appropriate for collection of water samples for volatile analysis. Other bailer types (messenger, bottom fill, etc.) are less desirable, but may be mandated by cost and site conditions.

7.4.1.1 Operation

1. Surround the monitor well with clean plastic sheeting. If using the GPI bailer, insert a vial into the claim and assemble the unit.
2. Attach a line to a clean decontaminated bailer.
3. Lower the bailer slowly and gently into the well, taking care not to shake the casing sides or to splash the bailer into the water. Stop lowering at a point adjacent to the screen.
4. Allow bailer to fill and then slowly and gently retrieve the bailer from the well avoiding contact with the casing, so as not to knock flakes of rust or other foreign materials into the bailer. If using the GPI bailer for collecting volatile organic samples,

once at the surface, remove the bailer from the cable. Carefully open the GPI bailer unit and remove the vial. Begin slowly pouring from the bailer, and collect the duplicate samples from the midstream sample.

5. Remove the cap from the sample container and place it on the plastic sheet or in a location where it won't become contaminated. See Section 7.7 for special considerations on VOA samples.
6. Begin slowly pouring from the bailer.
7. Filter and preserve samples as required by sampling plan.
8. Cap the sample container tightly and place prelabeled sample container in a carrier.
9. Replace the well cap.
10. Log all samples in the site logbook and on field data sheets and label all samples.
11. Package samples and complete necessary paperwork.
12. Transport sample to decontamination zone for preparation for transport to analytical laboratory.

7.4.2 Submersible Pumps

Although it is recommended that samples not be collected with a submersible pump due to the reasons stated in Section 4.4.2, there are some situations where they may be used.

7.4.2.1 Operation

1. Allow the monitor well to recharge after purging, keeping the pump just above screened section.
2. Attach gate valve to hose (if not already fitted), and reduce flow of water to a manageable sampling rate.
3. Assemble the appropriate bottles.
4. If no gate valve is available, run the water

- down the side of a clean jar and fill the sample bottles from the jar.
5. Cap the sample container tightly and place prelabeled sample container in a carrier.
 6. Replace the well cap.
 7. Log all samples in the site logbook and on the field data sheets and label all samples.
 8. Package samples and complete necessary paperwork.
 9. Transport sample to decontamination zone for preparation for transport to the analytical laboratory.
 10. Upon completion, remove pump and assembly and fully decontaminate prior to setting into the next sample well. Dedicate the tubing to the hole.

7.4.3 Non-Contact Gas Bladder Pumps

The use of a non-contact gas positive displacement bladder pump is often mandated by the use of dedicated pumps installed in wells. These pumps are also suitable for shallow (less than 100 feet) wells. They are somewhat difficult to clean, but may be used with dedicated sample tubing to avoid cleaning. These pumps require a power supply and a compressed gas supply (or compressor). They may be operated at variable flow and pressure rates making them ideal for both purging and sampling.

Barcelona (1984) and Nielsen (1985) report that the non-contact gas positive displacement pumps cause the least amount of alteration in sample integrity as compared to other sample retrieval methods.

7.4.3.1 Operation

1. Allow well to recharge after purging.
2. Assemble the appropriate bottles.
3. Turn pump on, increase the cycle time and reduce the pressure to the minimum that will allow the sample to come to the surface.
4. Cap the sample container tightly and place

prelabeled sample container in a carrier.

5. Replace the well cap.
6. Log all samples in the site logbook and on field data sheets and label all samples.
7. Package samples and complete necessary paperwork.
8. Transport sample to decontamination zone for preparation for transport to analytical laboratory.
9. On completion, remove the tubing from the well and either replace the Teflon tubing and bladder with new dedicated tubing and bladder or rigorously decontaminate the existing materials.
10. Nonfiltered samples shall be collected directly from the outlet tubing into the sample bottle.
11. For filtered samples, connect the pump outlet tubing directly to the filter unit. The pump pressure should remain decreased so that the pressure build up on the filter does not blow out the pump bladder or displace the filter. For the Geotech barrel filter, no actual connections are necessary so this is not a concern.

7.4.4 Suction Pumps

In view of the limitations of these type pumps, they are not recommended for sampling purposes.

7.4.5 Inertia Pumps

Inertia pumps may be used to collect samples. It is more common, however, to purge with these pumps and sample with a bailer (Section 7.4.1).

7.4.5.1 Operation

1. Following well evacuation, allow the well to recharge.
2. Assemble the appropriate bottles.
3. Since these pumps are manually operated,

the flow rate may be regulated by the sampler. The sample may be discharged from the pump outlet directly into the appropriate sample container.

4. Cap the sample container tightly and place prelabeled sample container in a carrier.
5. Replace the well cap.
6. Log all samples in the site logbook and on field data sheets and label all samples.
7. Package samples and complete necessary paperwork.
8. Transport sample to decontamination zone for preparation for transport to the analytical laboratory.
9. Upon completion, remove pump and decontaminate or discard, as appropriate.

7.4.6. Sample Retrieval - Syringe

A limited number of commercial syringe type samplers are available, (IEA, TIMCO, etc.) some are homemade devices. These devices are claimed to provide good quality samples for volatile analysis, but are severely limited in sample volume and are specific to sampling for volatiles. Essentially, they operated with an evacuated chamber that is lowered down the well, and allowed to fill with the pressure of the water. The entire mechanism is then brought to the surface with the sample. The sample may then be transferred to a sample vial, or the entire unit may be sent as the sample container.

1. Evacuate the syringe if necessary, and lower the sampling device to just below the well screen.
2. Remove the constriction from the device and allow the sample to fill the syringe, apply slight suction as necessary.
3. Bring unit to the surface. If necessary, transfer the sample to vials, as outlined in steps 2 through 7 above.

7.5 Filtering

For samples requiring filtering, such as total metals analysis, the filter must be decontaminated prior to and between uses. Filters work by two methods. A barrel filter such as the "Geotech" filter works with a bicycle pump, used to build up positive pressure in the chamber containing the sample which is then forced through the filter paper (minimum size 0.45 μm) into a jar placed underneath. The barrel itself is filled manually from the bailer or directly via the hose of the sampling pump. The pressure must be maintained up to 30 lbs/in² by periodic pumping.

A vacuum type filter involves two chambers; the upper chamber contains the sample and a filter (minimum size 0.45 μm) divides the chambers. Using a hand pump or a Gilian type pump, air is withdrawn from the lower chamber, creating a vacuum and thus causing the sample to move through the filter into the lower chamber where it is drained into a sample jar. Repeated pumping may be required to drain all the sample into the lower chamber. If preservation of the sample is necessary, this should be done after filtering.

7.6 Post Operation

After all samples are collected and preserved, the sampling equipment should be decontaminated prior to sampling another well to prevent cross-contamination of equipment and monitor wells between locations.

1. Decontaminate all equipment.
2. Replace sampling equipment in storage containers.
3. Prepare and transport ground water samples to the laboratory. Check sample documentation and make sure samples are properly packed for shipment.

7.7 Special Considerations for VOA Sampling

The proper collection of a sample for volatile organics requires minimal disturbance of the sample to limit volatilization and therefore a loss of volatiles from the sample.

Sample retrieval systems suitable for the valid collection of volatile organic samples are: positive displacement bladder pumps, gear driven submersible pumps, syringe samplers and bailers (Barcelona, 1984; Nielsen, 1985). Field conditions and other constraints will limit the choice of appropriate systems. The focus of concern must be to provide a valid sample for analysis, one which has been subjected to the least amount of turbulence possible.

The following procedures should be followed:

1. Open the vial, set cap in a clean place, and collect the sample during the middle of the cycle. When collecting duplicates, collect both samples at the same time.
2. Fill the vial to just overflowing. Do not rinse the vial, nor excessively overflow it. There should be a convex meniscus on the top of the vial.
3. Check that the cap has not been contaminated (splashed) and carefully cap the vial. Place the cap directly over the top and screw down firmly. Do not overtighten and break the cap.
4. Invert the vial and tap gently. Observe vial for at least ten (10) seconds. If an air bubble appears, discard the sample and begin again. It is imperative that no entrapped air is in the sample vial.
5. Immediately place the vial in the protective foam sleeve and place into the cooler, oriented so that it is lying on its side, not straight up.
6. The holding time for VOAs is seven days. Samples should be shipped or delivered to the laboratory daily so as not to exceed the holding time. Ensure that the samples remain at 4EC, but do not allow them to freeze.

8.0 CALCULATIONS

If it is necessary to calculate the volume of the well, utilize the following equation:

$$\text{Well volume} = \pi r^2 h (cf) \quad [\text{Equation 1}]$$

where:

$$\begin{aligned} \pi &= \text{pi} \\ r &= \text{radius of monitoring well (feet)} \\ h &= \text{height of the water column (feet)} \\ &\quad [\text{This may be determined by subtracting the depth to water from the total depth of the well as measured from the same reference point.}] \\ cf &= \text{conversion factor (gal/ft}^3\text{) = 7.48 gal/ft}^3 \text{ [In this equation, 7.48 gal/ft}^3 \text{ is the necessary conversion factor.]} \end{aligned}$$

Monitor well diameters are typically 2", 3", 4", or 6". Knowing the diameter of the monitor well, there are a number of standard conversion factors which can be used to simplify the equation above.

The volume, in gallons per linear foot, for various standard monitor well diameters can be calculated as follows:

$$v(\text{gal/ft}) = \pi r^2 (cf) \quad [\text{Equation 2}]$$

where:

$$\begin{aligned} \pi &= \text{pi} \\ r &= \text{radius of monitoring well (feet)} \\ cf &= \text{conversion factor (7.48 gal/ft}^3\text{)} \end{aligned}$$

For a 2" diameter well, the volume per linear foot can be calculated as follows:

$$\begin{aligned} \text{vol/linear ft} &= \pi r^2 (cf) \quad [\text{Equation 2}] \\ &= 3.14 (1/12 \text{ ft})^2 7.48 \text{ gal/ft}^3 \\ &= 0.1632 \text{ gal/ft} \end{aligned}$$

Remember that if you have a 2" diameter well, you must convert this to the radius in feet to be able to use the equation.

The conversion factors for the common size monitor wells are as follows:

Well diameter	2"	3"	4"	6"
Volume (gal/ft.)	0.1632	0.3672	0.6528	1.4688

If you utilize the conversion factors above, Equation

1 should be modified as follows:

$$\text{Well volume} = (h)(cf) \quad [\text{Equation 3}]$$

where:

h = height of water column (feet)
 cf = the conversion factor calculated from Equation 2

The well volume is typically tripled to determine the volume to be purged.

9.0 QUALITY ASSURANCE/ QUALITY CONTROL

There are no specific quality assurance (QA) activities which apply to the implementation of these procedures. However, the following general QA procedures apply:

1. All data must be documented on field data sheets or within site logbooks.
2. All instrumentation must be operated in accordance with operating instructions as supplied by the manufacturer, unless otherwise specified in the work plan. Equipment checkout and calibration activities must occur prior to sampling/operation and they must be documented.
3. The collection of rinsate blanks is recommended to evaluate potential for cross contamination from the purging and/or sampling equipment.
4. Trip blanks are required if analytical parameters include VOAs.

10.0 DATA VALIDATION

This section is not applicable to this SOP.

11.0 HEALTH AND SAFETY

When working with potentially hazardous materials, follow U.S. EPA, OSHA or REAC health and safety guidelines. More specifically, depending upon the site specific contaminants, various protective programs

must be implemented prior to sampling the first well. The site health and safety plan should be reviewed with specific emphasis placed on the protection program planned for the well sampling tasks. Standard safe operating practices should be followed such as minimizing contact with potential contaminants in both the vapor phase and liquid matrix through the use of respirators and disposable clothing.

When working around volatile organic contaminants:

1. Avoid breathing constituents venting from the well.
2. Pre-survey the well head-space with an FID/PID prior to sampling.
3. If monitoring results indicate organic constituents, sampling activities may be conducted in Level C protection. At a minimum, skin protection will be afforded by disposable protective clothing.

Physical hazards associated with well sampling:

1. Lifting injuries associated with pump and bailers retrieval; moving equipment.
2. Use of pocket knives for cutting discharge hose.
3. Heat/cold stress as a result of exposure to extreme temperatures and protective clothing.
4. Slip, trip, fall conditions as a result of pump discharge.
5. Restricted mobility due to the wearing of protective clothing.
6. Electrical shock associated with use of submersible pumps is possible. Use a GFCI or a copper grounding stake to avoid this problem.

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SAMPLING EQUIPMENT DECONTAMINATION

SOP#: 2006
DATE: 08/11/94
REV. #: 0.0

1.0 SCOPE AND APPLICATION

The purpose of this Standard Operating Procedure (SOP) is to provide a description of the methods used for preventing, minimizing, or limiting cross-contamination of samples due to inappropriate or inadequate equipment decontamination and to provide general guidelines for developing decontamination procedures for sampling equipment to be used during hazardous waste operations as per 29 Code of Federal Regulations (CFR) 1910.120. This SOP does not address personnel decontamination.

These are standard (i.e. typically applicable) operating procedures which may be varied or changed as required, dependent upon site conditions, equipment limitation, or limitations imposed by the procedure. In all instances, the ultimate procedures employed should be documented and associated with the final report.

Mention of trade names or commercial products does not constitute U.S. Environmental Protection Agency (U.S. EPA) endorsement or recommendation for use.

2.0 METHOD SUMMARY

Removing or neutralizing contaminants from equipment minimizes the likelihood of sample cross contamination, reduces or eliminates transfer of contaminants to clean areas, and prevents the mixing of incompatible substances.

Gross contamination can be removed by physical decontamination procedures. These abrasive and non-abrasive methods include the use of brushes, air and wet blasting, and high and low pressure water cleaning.

The first step, a soap and water wash, removes all visible particulate matter and residual oils and grease. This may be preceded by a steam or high pressure

water wash to facilitate residuals removal. The second step involves a tap water rinse and a distilled/deionized water rinse to remove the detergent. An acid rinse provides a low pH media for trace metals removal and is included in the decontamination process if metal samples are to be collected. It is followed by another distilled/deionized water rinse. If sample analysis does not include metals, the acid rinse step can be omitted. Next, a high purity solvent rinse is performed for trace organics removal if organics are a concern at the site. Typical solvents used for removal of organic contaminants include acetone, hexane, or water. Acetone is typically chosen because it is an excellent solvent, miscible in water, and not a target analyte on the Priority Pollutant List. If acetone is known to be a contaminant of concern at a given site or if Target Compound List analysis (which includes acetone) is to be performed, another solvent may be substituted. The solvent must be allowed to evaporate completely and then a final distilled/deionized water rinse is performed. This rinse removes any residual traces of the solvent.

The decontamination procedure described above may be summarized as follows:

1. Physical removal
2. Non-phosphate detergent wash
3. Tap water rinse
4. Distilled/deionized water rinse
5. 10% nitric acid rinse
6. Distilled/deionized water rinse
7. Solvent rinse (pesticide grade)
8. Air dry
9. Distilled/deionized water rinse

If a particular contaminant fraction is not present at the site, the nine (9) step decontamination procedure specified above may be modified for site specificity. For example, the nitric acid rinse may be eliminated if metals are not of concern at a site. Similarly, the solvent rinse may be eliminated if organics are not of

concern at a site. Modifications to the standard procedure should be documented in the site specific work plan or subsequent report.

3.0 SAMPLE PRESERVATION, CONTAINERS, HANDLING, AND STORAGE

The amount of sample to be collected and the proper sample container type (i.e., glass, plastic), chemical preservation, and storage requirements are dependent on the matrix being sampled and the parameter(s) of interest.

More specifically, sample collection and analysis of decontamination waste may be required before beginning proper disposal of decontamination liquids and solids generated at a site. This should be determined prior to initiation of site activities.

4.0 INTERFERENCES AND POTENTIAL PROBLEMS

C The use of distilled/deionized water commonly available from commercial vendors may be acceptable for decontamination of sampling equipment provided that it has been verified by laboratory analysis to be analyte free (specifically for the contaminants of concern).

C The use of an untreated potable water supply is not an acceptable substitute for tap water. Tap water may be used from any municipal or industrial water treatment system.

C If acids or solvents are utilized in decontamination they raise health and safety, and waste disposal concerns.

C Damage can be incurred by acid and solvent washing of complex and sophisticated sampling equipment.

5.0 EQUIPMENT/APPARATUS

Decontamination equipment, materials, and supplies are generally selected based on availability. Other considerations include the ease of decontaminating or disposing of the equipment. Most equipment and supplies can be easily procured. For example, soft-

bristle scrub brushes or long-handled bottle brushes can be used to remove contaminants. Large galvanized wash tubs, stock tanks, or buckets can hold wash and rinse solutions. Children's wading pools can also be used. Large plastic garbage cans or other similar containers lined with plastic bags can help segregate contaminated equipment. Contaminated liquid can be stored temporarily in metal or plastic cans or drums.

The following standard materials and equipment are recommended for decontamination activities:

5.1 Decontamination Solutions

C Non-phosphate detergent
C Selected solvents (acetone, hexane, nitric acid, etc.)
C Tap water
C Distilled or deionized water

5.2 Decontamination Tools/Supplies

C Long and short handled brushes
C Bottle brushes
C Drop cloth/plastic sheeting
C Paper towels
C Plastic or galvanized tubs or buckets
C Pressurized sprayers (H₂O)
C Solvent sprayers
C Aluminum foil

5.3 Health and Safety Equipment

Appropriate personal protective equipment (i.e., safety glasses or splash shield, appropriate gloves, aprons or coveralls, respirator, emergency eye wash)

5.4 Waste Disposal

C Trash bags
C Trash containers
C 55-gallon drums
C Metal/plastic buckets/containers for storage and disposal of decontamination solutions

6.0 REAGENTS

There are no reagents used in this procedure aside from the actual decontamination solutions. Table 1 (Appendix A) lists solvent rinses which may be required for elimination of particular chemicals. In

general, the following solvents are typically utilized for decontamination purposes:

- C 10% nitric acid is typically used for inorganic compounds such as metals. An acid rinse may not be required if inorganics are not a contaminant of concern.
- C Acetone (pesticide grade)⁽¹⁾
- C Hexane (pesticide grade)⁽¹⁾
- C Methanol⁽¹⁾

⁽¹⁾ - Only if sample is to be analyzed for organics.

7.0 PROCEDURES

As part of the health and safety plan, a decontamination plan should be developed and reviewed. The decontamination line should be set up before any personnel or equipment enter the areas of potential exposure. The equipment decontamination plan should include:

- C The number, location, and layout of decontamination stations.
- C Decontamination equipment needed.
- C Appropriate decontamination methods.
- C Methods for disposal of contaminated clothing, equipment, and solutions.
- C Procedures can be established to minimize the potential for contamination. This may include: (1) work practices that minimize contact with potential contaminants; (2) using remote sampling techniques; (3) covering monitoring and sampling equipment with plastic, aluminum foil, or other protective material; (4) watering down dusty areas; (5) avoiding laying down equipment in areas of obvious contamination; and (6) use of disposable sampling equipment.

7.1 Decontamination Methods

All samples and equipment leaving the contaminated area of a site must be decontaminated to remove any contamination that may have adhered to equipment. Various decontamination methods will remove contaminants by: (1) flushing or other physical action, or (2) chemical complexing to inactivate

contaminants by neutralization, chemical reaction, disinfection, or sterilization.

Physical decontamination techniques can be grouped into two categories: abrasive methods and non-abrasive methods, as follows:

7.1.1 Abrasive Cleaning Methods

Abrasive cleaning methods work by rubbing and wearing away the top layer of the surface containing the contaminant. The mechanical abrasive cleaning methods are most commonly used at hazardous waste sites. The following abrasive methods are available:

Mechanical

Mechanical methods of decontamination include using metal or nylon brushes. The amount and type of contaminants removed will vary with the hardness of bristles, length of time brushed, degree of brush contact, degree of contamination, nature of the surface being cleaned, and degree of contaminant adherence to the surface.

Air Blasting

Air blasting equipment uses compressed air to force abrasive material through a nozzle at high velocities. The distance between nozzle and surface cleaned, air pressure, time of application, and angle at which the abrasive strikes the surface will dictate cleaning efficiency. Disadvantages of this method are the inability to control the amount of material removed and the large amount of waste generated.

Wet Blasting

Wet blast cleaning involves use of a suspended fine abrasive. The abrasive/water mixture is delivered by compressed air to the contaminated area. By using a very fine abrasive, the amount of materials removed can be carefully controlled.

7.1.2 Non-Abrasive Cleaning Methods

Non-abrasive cleaning methods work by forcing the contaminant off a surface with pressure. In general, the equipment surface is not removed using non-abrasive methods.

Low-Pressure Water

This method consists of a container which is filled with water. The user pumps air out of the container to create a vacuum. A slender nozzle and hose allow the user to spray in hard-to-reach places.

High-Pressure Water

This method consists of a high-pressure pump, an operator controlled directional nozzle, and a high-pressure hose. Operating pressure usually ranges from 340 to 680 atmospheres (atm) and flow rates usually range from 20 to 140 liters per minute.

Ultra-High-Pressure Water

This system produces a water jet that is pressured from 1,000 to 4,000 atmospheres. This ultra-high-pressure spray can remove tightly-adhered surface films. The water velocity ranges from 500 meters/second (m/s) (1,000 atm) to 900 m/s (4,000 atm). Additives can be used to enhance the cleaning action.

Rinsing

Contaminants are removed by rinsing through dilution, physical attraction, and solubilization.

Damp Cloth Removal

In some instances, due to sensitive, non-waterproof equipment or due to the unlikelihood of equipment being contaminated, it is not necessary to conduct an extensive decontamination procedure. For example, air sampling pumps hooked on a fence, placed on a drum, or wrapped in plastic bags are not likely to become heavily contaminated. A damp cloth should be used to wipe off contaminants which may have adhered to equipment through airborne contaminants or from surfaces upon which the equipment was set.

Disinfection/Sterilization

Disinfectants are a practical means of inactivating infectious agents. Unfortunately, standard sterilization methods are impractical for large equipment. This method of decontamination is typically performed off-site.

7.2 Field Sampling Equipment Decontamination Procedures

The decontamination line is setup so that the first station is used to clean the most contaminated item. It progresses to the last station where the least contaminated item is cleaned. The spread of contaminants is further reduced by separating each decontamination station by a minimum of three (3) feet. Ideally, the contamination should decrease as the equipment progresses from one station to another farther along in the line.

A site is typically divided up into the following boundaries: Hot Zone or Exclusion Zone (EZ), the Contamination Reduction Zone (CRZ), and the Support or Safe Zone (SZ). The decontamination line should be setup in the Contamination Reduction Corridor (CRC) which is in the CRZ. Figure 1 (Appendix B) shows a typical contaminant reduction zone layout. The CRC controls access into and out of the exclusion zone and confines decontamination activities to a limited area. The CRC boundaries should be conspicuously marked. The far end is the hotline, the boundary between the exclusion zone and the contamination reduction zone. The size of the decontamination corridor depends on the number of stations in the decontamination process, overall dimensions of the work zones, and amount of space available at the site. Whenever possible, it should be a straight line.

Anyone in the CRC should be wearing the level of protection designated for the decontamination crew. Another corridor may be required for the entry and exit of heavy equipment. Sampling and monitoring equipment and sampling supplies are all maintained outside of the CRC. Personnel don their equipment away from the CRC and enter the exclusion zone through a separate access control point at the hotline. One person (or more) dedicated to decontaminating equipment is recommended.

7.2.1 Decontamination Setup

Starting with the most contaminated station, the decontamination setup should be as follows:

Station 1: Segregate Equipment Drop

Place plastic sheeting on the ground (Figure 2, Appendix B). Size will depend on amount of

equipment to be decontaminated. Provide containers lined with plastic if equipment is to be segregated. Segregation may be required if sensitive equipment or mildly contaminated equipment is used at the same time as equipment which is likely to be heavily contaminated.

Station 2: Physical Removal With A High-Pressure Washer (Optional)

As indicated in 7.1.2, a high-pressure wash may be required for compounds which are difficult to remove by washing with brushes. The elevated temperature of the water from the high-pressure washers is excellent at removing greasy/oily compounds. High pressure washers require water and electricity.

A decontamination pad may be required for the high-pressure wash area. An example of a wash pad may consist of an approximately 1 1/2 foot-deep basin lined with plastic sheeting and sloped to a sump at one corner. A layer of sand can be placed over the plastic and the basin is filled with gravel or shell. The sump is also lined with visqueen and a barrel is placed in the hole to prevent collapse. A sump pump is used to remove the water from the sump for transfer into a drum.

Typically heavy machinery is decontaminated at the end of the day unless site sampling requires that the machinery be decontaminated frequently. A separate decontamination pad may be required for heavy equipment.

Station 3: Physical Removal With Brushes And A Wash Basin

Prior to setting up Station 3, place plastic sheeting on the ground to cover areas under Station 3 through Station 10.

Fill a wash basin, a large bucket, or child's swimming pool with non-phosphate detergent and tap water. Several bottle and bristle brushes to physically remove contamination should be dedicated to this station. Approximately 10 - 50 gallons of water may be required initially depending upon the amount of equipment to decontaminate and the amount of gross contamination.

Station 4: Water Basin

Fill a wash basin, a large bucket, or child's swimming

pool with tap water. Several bottle and bristle brushes should be dedicated to this station. Approximately 10-50 gallons of water may be required initially depending upon the amount of equipment to decontaminate and the amount of gross contamination.

Station 5: Low-Pressure Sprayers

Fill a low-pressure sprayer with distilled/deionized water. Provide a 5-gallon bucket or basin to contain the water during the rinsing process. Approximately 10-20 gallons of water may be required initially depending upon the amount of equipment to decontaminate and the amount of gross contamination.

Station 6: Nitric Acid Sprayers

Fill a spray bottle with 10% nitric acid. An acid rinse may not be required if inorganics are not a contaminant of concern. The amount of acid will depend on the amount of equipment to be decontaminated. Provide a 5-gallon bucket or basin to collect acid during the rinsing process.

Station 7: Low-Pressure Sprayers

Fill a low-pressure sprayer with distilled/deionized water. Provide a 5-gallon bucket or basin to collect water during the rinsate process.

Station 8: Organic Solvent Sprayers

Fill a spray bottle with an organic solvent. After each solvent rinse, the equipment should be rinsed with distilled/deionized water and air dried. Amount of solvent will depend on the amount of equipment to decontaminate. Provide a 5-gallon bucket or basin to collect the solvent during the rinsing process.

Solvent rinses may not be required unless organics are a contaminant of concern, and may be eliminated from the station sequence.

Station 9: Low-Pressure Sprayers

Fill a low-pressure sprayer with distilled/deionized water. Provide a 5-gallon bucket or basin to collect water during the rinsate process.

Station 10: Clean Equipment Drop

Lay a clean piece of plastic sheeting over the bottom

plastic layer. This will allow easy removal of the plastic in the event that it becomes dirty. Provide aluminum foil, plastic, or other protective material to wrap clean equipment.

7.2.2 Decontamination Procedures

Station 1: Segregate Equipment Drop

Deposit equipment used on-site (i.e., tools, sampling devices and containers, monitoring instruments radios, clipboards, etc.) on the plastic drop cloth/sheet or in different containers with plastic liners. Each will be contaminated to a different degree. Segregation at the drop reduces the probability of cross contamination. Loose leaf sampling data sheets or maps can be placed in plastic zip lock bags if contamination is evident.

Station 2: Physical Removal With A High-Pressure Washer (Optional)

Use high pressure wash on grossly contaminated equipment. Do not use high- pressure wash on sensitive or non-waterproof equipment.

Station 3: Physical Removal With Brushes And A Wash Basin

Scrub equipment with soap and water using bottle and bristle brushes. Only sensitive equipment (i.e., radios, air monitoring and sampling equipment) which is waterproof should be washed. Equipment which is not waterproof should have plastic bags removed and wiped down with a damp cloth. Acids and organic rinses may also ruin sensitive equipment. Consult the manufacturers for recommended decontamination solutions.

Station 4: Equipment Rinse

Wash soap off of equipment with water by immersing the equipment in the water while brushing. Repeat as many times as necessary.

Station 5: Low-Pressure Rinse

Rinse sampling equipment with distilled/deionized water with a low-pressure sprayer.

Station 6: Nitric Acid Sprayers (required only if metals are a contaminant of concern)

Using a spray bottle rinse sampling equipment with nitric acid. Begin spraying (inside and outside) at one end of the equipment allowing the acid to drip to the other end into a 5-gallon bucket. A rinsate blank may be required at this station. Refer to Section 9.

Station 7: Low-Pressure Sprayers

Rinse sampling equipment with distilled/deionized water with a low-pressure sprayer.

Station 8: Organic Solvent Sprayers

Rinse sampling equipment with a solvent. Begin spraying (inside and outside) at one end of the equipment allowing the solvent to drip to the other end into a 5-gallon bucket. Allow the solvent to evaporate from the equipment before going to the next station. A QC rinsate sample may be required at this station.

Station 9: Low-Pressure Sprayers

Rinse sampling equipment with distilled/deionized water with a low-pressure washer.

Station 10: Clean Equipment Drop

Lay clean equipment on plastic sheeting. Once air dried, wrap sampling equipment with aluminum foil, plastic, or other protective material.

7.2.3 Post Decontamination Procedures

1. Collect high-pressure pad and heavy equipment decontamination area liquid and waste and store in appropriate drum or container. A sump pump can aid in the collection process. Refer to the Department of Transportation (DOT) requirements for appropriate containers based on the contaminant of concern.
2. Collect high-pressure pad and heavy equipment decontamination area solid waste and store in appropriate drum or container. Refer to the DOT requirements for appropriate containers based on the contaminant of concern.
3. Empty soap and water liquid wastes from basins and buckets and store in appropriate

drum or container. Refer to the DOT requirements for appropriate containers based on the contaminant of concern.

4. Empty acid rinse waste and place in appropriate container or neutralize with a base and place in appropriate drum. pH paper or an equivalent pH test is required for neutralization. Consult DOT requirements for appropriate drum for acid rinse waste.
5. Empty solvent rinse sprayer and solvent waste into an appropriate container. Consult DOT requirements for appropriate drum for solvent rinse waste.
6. Using low-pressure sprayers, rinse basins, and brushes. Place liquid generated from this process into the wash water rinse container.
7. Empty low-pressure sprayer water onto the ground.
8. Place all solid waste materials generated from the decontamination area (i.e., gloves and plastic sheeting, etc.) in an approved DOT drum. Refer to the DOT requirements for appropriate containers based on the contaminant of concern.
9. Write appropriate labels for waste and make arrangements for disposal. Consult DOT regulations for the appropriate label for each drum generated from the decontamination process.

8.0 CALCULATIONS

This section is not applicable to this SOP.

9.0 QUALITY ASSURANCE/ QUALITY CONTROL

A rinsate blank is one specific type of quality control sample associated with the field decontamination process. This sample will provide information on the effectiveness of the decontamination process employed in the field.

Rinsate blanks are samples obtained by running analyte free water over decontaminated sampling

equipment to test for residual contamination. The blank water is collected in sample containers for handling, shipment, and analysis. These samples are treated identical to samples collected that day. A rinsate blank is used to assess cross contamination brought about by improper decontamination procedures. Where dedicated sampling equipment is not utilized, collect one rinsate blank per day per type of sampling device samples to meet QA2 and QA3 objectives.

If sampling equipment requires the use of plastic tubing it should be disposed of as contaminated and replaced with clean tubing before additional sampling occurs.

10.0 DATA VALIDATION

Results of quality control samples will be evaluated for contamination. This information will be utilized to qualify the environmental sample results in accordance with the project's data quality objectives.

11.0 HEALTH AND SAFETY

When working with potentially hazardous materials, follow OSHA, U.S. EPA, corporate, and other applicable health and safety procedures.

Decontamination can pose hazards under certain circumstances. Hazardous substances may be incompatible with decontamination materials. For example, the decontamination solution may react with contaminants to produce heat, explosion, or toxic products. Also, vapors from decontamination solutions may pose a direct health hazard to workers by inhalation, contact, fire, or explosion.

The decontamination solutions must be determined to be acceptable before use. Decontamination materials may degrade protective clothing or equipment; some solvents can permeate protective clothing. If decontamination materials do pose a health hazard, measures should be taken to protect personnel or substitutions should be made to eliminate the hazard. The choice of respiratory protection based on contaminants of concern from the site may not be appropriate for solvents used in the decontamination process.

Safety considerations should be addressed when using abrasive and non-abrasive decontamination

equipment. Maximum air pressure produced by abrasive equipment could cause physical injury. Displaced material requires control mechanisms.

Material generated from decontamination activities requires proper handling, storage, and disposal. Personal Protective Equipment may be required for these activities.

Material safety data sheets are required for all decontamination solvents or solutions as required by the Hazard Communication Standard (i.e., acetone, alcohol, and trisodiumphosphate).

In some jurisdictions, phosphate containing detergents (i.e., TSP) are banned.

12.0 REFERENCES

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APPENDIX A

Table

Table 1. Soluble Contaminants and Recommended Solvent Rinse

TABLE 1 Soluble Contaminants and Recommended Solvent Rinse		
SOLVENT ⁽¹⁾	EXAMPLES OF SOLVENTS	SOLUBLE CONTAMINANTS
Water	Deionized water Tap water	Low-chain hydrocarbons Inorganic compounds Salts Some organic acids and other polar compounds
Dilute Acids	Nitric acid Acetic acid Boric acid	Basic (caustic) compounds (e.g., amines and hydrazines)
Dilute Bases	Sodium bicarbonate (e.g., soap detergent)	Acidic compounds Phenol Thiols Some nitro and sulfonic compounds
Organic Solvents ⁽²⁾	Alcohols Ethers Ketones Aromatics Straight chain alkalines (e.g., hexane) Common petroleum products (e.g., fuel, oil, kerosene)	Nonpolar compounds (e.g., some organic compounds)
Organic Solvent ⁽²⁾	Hexane	PCBs

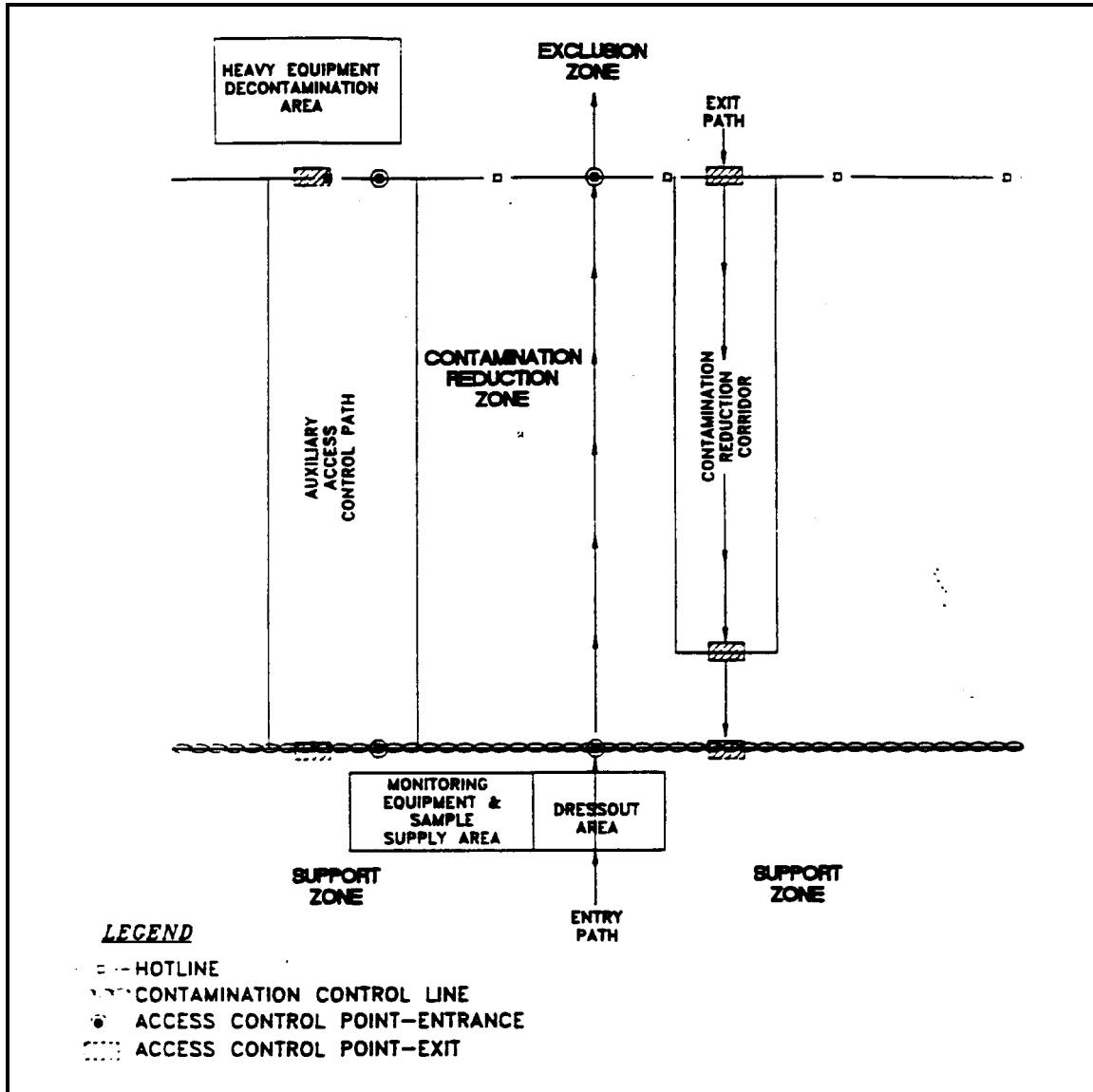
⁽¹⁾ - Material safety data sheets are required for all decontamination solvents or solutions as required by the Hazard Communication Standard

⁽²⁾ - WARNING: Some organic solvents can permeate and/or degrade the protective clothing

APPENDIX B

Figures

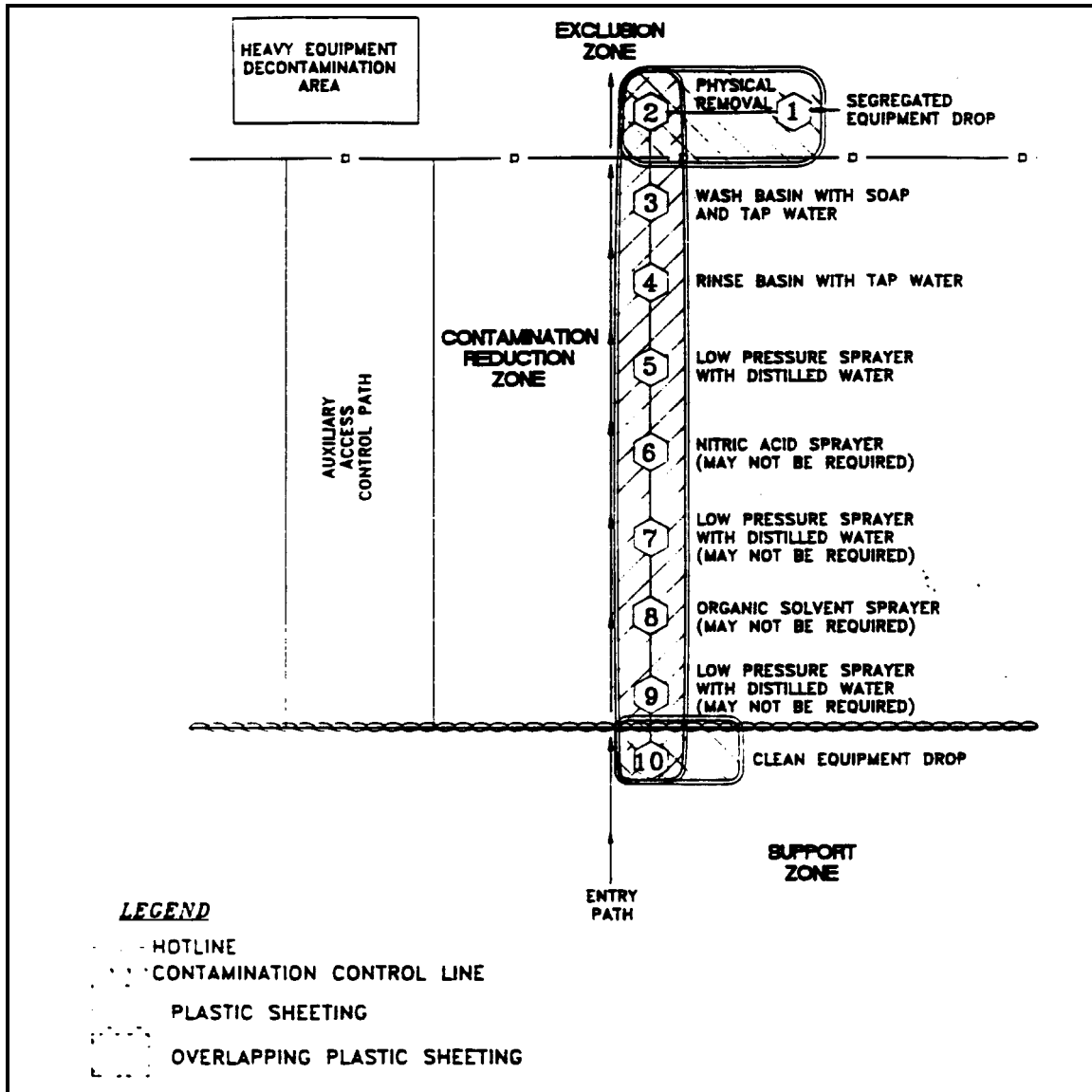
Figure 1. Contamination Reduction Zone Layout



APPENDIX B (Cont'd.)

Figures

Figure 2. Decontamination Layout





GENERAL FIELD SAMPLING GUIDELINES

SOP#: 2001
DATE: 08/11/94
REV. #: 0.0

1.0 SCOPE AND APPLICATION

The purpose of this Standard Operating Procedure (SOP) is to provide general field sampling guidelines that will assist REAC personnel in choosing sampling strategies, location, and frequency for proper assessment of site characteristics. This SOP is applicable to all field activities that involve sampling.

These are standard (i.e., typically applicable) operating procedures which may be varied or changed as required, dependent on site conditions, equipment limitations or limitations imposed by the procedure. In all instances, the ultimate procedures employed should be documented and associated with the final report.

Mention of trade names or commercial products does not constitute U.S. EPA endorsement or recommendation for use.

2.0 METHOD SUMMARY

Sampling is the selection of a representative portion of a larger population, universe, or body. Through examination of a sample, the characteristics of the larger body from which the sample was drawn can be inferred. In this manner, sampling can be a valuable tool for determining the presence, type, and extent of contamination by hazardous substances in the environment.

The primary objective of all sampling activities is to characterize a hazardous waste site accurately so that its impact on human health and the environment can be properly evaluated. It is only through sampling and analysis that site hazards can be measured and the job of cleanup and restoration can be accomplished effectively with minimal risk. The sampling itself must be conducted so that every sample collected retains its original physical form and chemical composition. In this way, sample integrity is insured, quality assurance standards are maintained, and the sample can accurately represent the larger body of

material under investigation.

The extent to which valid inferences can be drawn from a sample depends on the degree to which the sampling effort conforms to the project's objectives. For example, as few as one sample may produce adequate, technically valid data to address the project's objectives. Meeting the project's objectives requires thorough planning of sampling activities, and implementation of the most appropriate sampling and analytical procedures. These issues will be discussed in this procedure.

3.0 SAMPLE PRESERVATION, CONTAINERS, HANDLING, AND STORAGE

The amount of sample to be collected, and the proper sample container type (i.e., glass, plastic), chemical preservation, and storage requirements are dependent on the matrix being sampled and the parameter(s) of interest. Sample preservation, containers, handling, and storage for air and waste samples are discussed in the specific SOPs for air and waste sampling techniques.

4.0 INTERFERENCES AND POTENTIAL PROBLEMS

The nature of the object or materials being sampled may be a potential problem to the sampler. If a material is homogeneous, it will generally have a uniform composition throughout. In this case, any sample increment can be considered representative of the material. On the other hand, heterogeneous samples present problems to the sampler because of changes in the material over distance, both laterally and vertically.

Samples of hazardous materials may pose a safety threat to both field and laboratory personnel. Proper health and safety precautions should be implemented when handling this type of sample.

Environmental conditions, weather conditions, or non-target chemicals may cause problems and/or interferences when performing sampling activities or when sampling for a specific parameter. Refer to the specific SOPs for sampling techniques.

5.0 EQUIPMENT/APPARATUS

The equipment/apparatus required to collect samples must be determined on a site specific basis. Due to the wide variety of sampling equipment available, refer to the specific SOPs for sampling techniques which include lists of the equipment/apparatus required for sampling.

6.0 REAGENTS

Reagents may be utilized for preservation of samples and for decontamination of sampling equipment. The preservatives required are specified by the analysis to be performed. Decontamination solutions are specified in ERT SOP #2006, Sampling Equipment Decontamination.

7.0 PROCEDURE

7.1 Types of Samples

In relation to the media to be sampled, two basic types of samples can be considered: the environmental sample and the hazardous sample.

Environmental samples are those collected from streams, ponds, lakes, wells, and are off-site samples that are not expected to be contaminated with hazardous materials. They usually do not require the special handling procedures typically used for concentrated wastes. However, in certain instances, environmental samples can contain elevated concentrations of pollutants and in such cases would have to be handled as hazardous samples.

Hazardous or concentrated samples are those collected from drums, tanks, lagoons, pits, waste piles, fresh spills, or areas previously identified as contaminated, and require special handling procedures because of their potential toxicity or hazard. These samples can be further subdivided based on their degree of hazard; however, care should be taken when handling and shipping any wastes believed to be concentrated regardless of the degree.

The importance of making the distinction between environmental and hazardous samples is two-fold:

- (1) Personnel safety requirements: Any sample thought to contain enough hazardous materials to pose a safety threat should be designated as hazardous and handled in a manner which ensures the safety of both field and laboratory personnel.
- (2) Transportation requirements: Hazardous samples must be packaged, labeled, and shipped according to the International Air Transport Association (IATA) Dangerous Goods Regulations or Department of Transportation (DOT) regulations and U.S. EPA guidelines.

7.2 Sample Collection Techniques

In general, two basic types of sample collection techniques are recognized, both of which can be used for either environmental or hazardous samples.

Grab Samples

A grab sample is defined as a discrete aliquot representative of a specific location at a given point in time. The sample is collected all at once at one particular point in the sample medium. The representativeness of such samples is defined by the nature of the materials being sampled. In general, as sources vary over time and distance, the representativeness of grab samples will decrease.

Composite Samples

Composites are nondiscrete samples composed of more than one specific aliquot collected at various sampling locations and/or different points in time. Analysis of this type of sample produces an average value and can in certain instances be used as an alternative to analyzing a number of individual grab samples and calculating an average value. It should be noted, however, that compositing can mask problems by diluting isolated concentrations of some hazardous compounds below detection limits.

Compositing is often used for environmental samples and may be used for hazardous samples under certain conditions. For example, compositing of hazardous waste is often performed after compatibility tests have

been completed to determine an average value over a number of different locations (group of drums). This procedure generates data that can be useful by providing an average concentration within a number of units, can serve to keep analytical costs down, and can provide information useful to transporters and waste disposal operations.

For sampling situations involving hazardous wastes, grab sampling techniques are generally preferred because grab sampling minimizes the amount of time sampling personnel must be in contact with the wastes, reduces risks associated with compositing unknowns, and eliminates chemical changes that might occur due to compositing.

7.3 Types of Sampling Strategies

The number of samples that should be collected and analyzed depends on the objective of the investigation. There are three basic sampling strategies: random, systematic, and judgmental sampling.

Random sampling involves collection of samples in a nonsystematic fashion from the entire site or a specific portion of a site. Systematic sampling involves collection of samples based on a grid or a pattern which has been previously established. When judgmental sampling is performed, samples are collected only from the portion(s) of the site most likely to be contaminated. Often, a combination of these strategies is the best approach depending on the type of the suspected/known contamination, the uniformity and size of the site, the level/type of information desired, etc.

7.4 QA Work Plans (QAWP)

A QAWP is required when it becomes evident that a field investigation is necessary. It should be initiated in conjunction with, or immediately following, notification of the field investigation. This plan should be clear and concise and should detail the following basic components, with regard to sampling activities:

- C Objective and purpose of the investigation.
- C Basis upon which data will be evaluated.
- C Information known about the site including location, type and size of the facility, and length of operations/abandonment.
- C Type and volume of contaminated material, contaminants of concern (including

concentration), and basis of the information/data.

- C Technical approach including media/matrix to be sampled, sampling equipment to be used, sample equipment decontamination (if necessary), sampling design and rationale, and SOPs or description of the procedure to be implemented.
- C Project management and reporting, schedule, project organization and responsibilities, manpower and cost projections, and required deliverables.
- C QA objectives and protocols including tables summarizing field sampling and QA/QC analysis and objectives.

Note that this list of QAWP components is not all-inclusive and that additional elements may be added or altered depending on the specific requirements of the field investigation. It should also be recognized that although a detailed QAWP is quite important, it may be impractical in some instances. Emergency responses and accidental spills are prime examples of such instances where time might prohibit the development of site-specific QAWPs prior to field activities. In such cases, investigators would have to rely on general guidelines and personal judgment, and the sampling or response plans might simply be a strategy based on preliminary information and finalized on site. In any event, a plan of action should be developed, no matter how concise or informal, to aid investigators in maintaining a logical and consistent order to the implementation of their task.

7.5 Legal Implications

The data derived from sampling activities are often introduced as critical evidence during litigation of a hazardous waste site cleanup. Legal issues in which sampling data are important may include cleanup cost recovery, identification of pollution sources and responsible parties, and technical validation of remedial design methodologies. Because of the potential for involvement in legal actions, strict adherence to technical and administrative SOPs is essential during both the development and implementation of sampling activities.

Technically valid sampling begins with thorough planning and continues through the sample collection and analytical procedures. Administrative requirements involve thorough, accurate

documentation of all sampling activities. Documentation requirements include maintenance of a chain of custody, as well as accurate records of field activities and analytical instructions. Failure to observe these procedures fully and consistently may result in data that are questionable, invalid and non-defensible in court, and the consequent loss of enforcement proceedings.

8.0 CALCULATIONS

Refer to the specific SOPs for any calculations which are associated with sampling techniques.

9.0 QUALITY ASSURANCE/ QUALITY CONTROL

Refer to the specific SOPs for the type and frequency of QA/QC samples to be analyzed, the acceptance criteria for the QA/QC samples, and any other QA/QC activities which are associated with sampling techniques.

10.0 DATA VALIDATION

Refer to the specific SOPs for data validation activities that are associated with sampling techniques.

11.0 HEALTH AND SAFETY

When working with potentially hazardous materials, follow U.S. EPA, OSHA, and corporate health and safety procedures.

SUPERFUND TECHNICAL ASSESSMENT RESPONSE TEAM
STANDARD OPERATING PROCEDURE

SOP 210
FIELD pH, CONDUCTIVITY, AND TEMPERATURE MEASUREMENT

1.0 INTRODUCTION

The purpose of this Standard Operating Procedure (SOP) is to provide Roy F. Weston, Inc. (WESTON®), Superfund Technical Assessment Response Team (START) members with a step-by-step guide to measure pH, conductivity, and temperature with a digital conductance, temperature and pH testing instrument.

2.0 CALIBRATION INSTRUCTIONS

Prior to instrumentation use, it is important to calibrate the instrument to check its accuracy. Since the temperature is pre-set at the factory, only the pH and conductivity need to be recalibrated.

1. Conductivity may be calibrated by removing the black plug to expose the adjustment potentiometer screw.
2. Add the standard solution to the cup, discard and refill.
3. Repeat this procedure until the digital display indicates the same value twice in a row. Adjust the potentiometer until the digital display indicates the known value of conductivity. To increase the digital display reading, turn the adjustment potentiometer screw counterclockwise (clockwise to decrease).
4. Place the pH electrode in the 7.0 buffer solution to standardize the pH electrode and meter. Adjust the “zero” potentiometer on the face of the tester so that the digital display indicates 7.00.
5. Place the pH electrode in the 4.0 or 10.0 buffer solution (depending on the desired measurement). Adjust the slope potentiometer on the face of the tester so that the digital display indicates the value of the buffer chosen. It is important to note that there will be interaction between the “zero” and the “slope” adjustments, therefore, the procedure should be repeated several times.

3.0 OPERATING INSTRUCTIONS

1. Fill the clean sample cup at least 2/3 full. If the sample is hot broiler water, allow the water to cool to 160°F or below.
2. Slide the right-hand function switch to “TEMP” and push the “READ” button. If the reading is not stable, empty and refill the cup several times to bring the cup and the sample to the same temperature.
3. Read the temperature on the digital display panel and adjust both the temperature compensation knobs accordingly.

4. If the approximate conductivity is known, slide the left-hand range selector switch to the proper range, i.e., if you expect the sample to be approximately 2000 micromhos, slide the left-hand selector switch to x 1000.
5. Slide the right-hand function switch to "COND" and push the "READ" button.
6. Multiply the digital display reading by the factor indicated by the position of the left-hand range switch to determine conductivity, i.e., a display reading of 1.00 with the left-hand range selector switch indicating x 1000 is: 1.00×1000 micromhos/centimeter.
NOTE: If a single "1" appears on the left-hand side of the digital display, the sample conductivity is higher than the selected range. Slide the left-hand (range) selector switch in one step intervals until a 3 or 4 digit number (1.00 or larger) appears on the display. Caution: A single "1" always means that the conductivity is higher than the selected range.
7. Slide the right-hand function selector switch to "pH".
8. Insert the pH cable connector into the tester. Push in and twist clockwise.
9. Remove the tape from the plastic storage cap, and proceed to remove the storage cap.
10. Place the pH electrode in the sample cup or any non-metallic container holding the remainder of the sample to be measured. If you use the tester's sample cup, you will have to hold the electrode.
11. Press the "READ" button. The pH value will appear on the digital display.
12. Always obtain a conductivity reading before placing the pH probe in the sample cup. It is important to remember that the pH probe may contaminate the sample.

4.0 MAINTENANCE

It is important to wipe the sample cup after every sample and rinse the cap with tap water when possible. The battery is located behind the snap-off cover on the bottom of the tester and should be replaced with a 9-volt whenever "LO BAT" appears on the display.

5.0 REFERENCE

Instruction Manual for Digital Conductance, Temperature, and pH Tester. Catalog No. 015235 Celsius, No. 016495.

SUPERFUND TECHNICAL ASSESSMENT RESPONSE TEAM
STANDARD OPERATING PROCEDURES

SOP 204
WATER LEVEL MEASUREMENTS

1.0 PURPOSE

Roy F. Weston, Inc. (WESTON) has adopted the American Society for Testing and Materials (ASTM) Standard Method D4750-87 as its standard operating procedure for *Determining Subsurface Liquid Levels in a Borehole or Monitoring Well* (see attachment).

2.0 INTERPRETATION

If there are questions regarding the interpretation or the applicability of items in this operating practice, the Project Manager or Technical Manager should be consulted. In the absence of either of those, contact your Section Manager.

3.0 REFERENCES

American Society for Testing and Materials (ASTM) Standards on Groundwater and Vadose Zone Investigation, 1992, pages 113-118.

Attachment: 1

ATTACHMENT 1

**AMERICAN SOCIETY FOR TESTING AND MATERIALS
DESIGNATION: D4750-87**

American Society for Testing and Materials Designation: D4750-87

**Standard Test Method for Determining Subsurface
Liquid Levels in a Borehole or Monitoring Well
(Observation Well)¹**

This standard is issued under the fixed designation D4750; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

1.0 Scope

- 1.1** This test method describes the procedures for measuring the level of liquid in a borehole or well and determining the stabilized level of liquid in a borehole.
- 1.2** The test method applies to boreholes (cased or uncased) and monitoring wells (observation wells) that are vertical or sufficiently vertical so a flexible measuring device can be lowered into the hole.
- 1.3** Borehole liquid-level measurements obtained using this method will not necessarily correspond to the level of the liquid in the vicinity of the borehole unless sufficient time has been allowed for the level to reach equilibrium position.
- 1.4** This test method generally is not applicable for the determination of pore-pressure changes due to changes in stress conditions of the earth material.
- 1.5** This test method is not applicable for the concurrent determination of multiple liquid levels in a borehole.
- 1.6** The values stated in inch-pound units are to be regarded as the standard.
- 1.7** *This standard may involve hazardous materials, operations, and equipment. This standard does not purport to address all of the safety problems associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

¹ This test method is under the jurisdiction of ASTM Committee D-18 on Soil and Rock and is in direct responsibility of Subcommittee D18.02 on Sampling and Related Field Testing for Soil Investigations. Current edition approved Nov. 27, 1987. Published January 1988.

2.0 Referenced Document

- 2.1** *ASTM Standard:*
D653 Terminology Relating to Soil, Rock, and Contained Fluids² .

3.0 Terminology

- 3.1** *Descriptions of Terms Specific to This Standard:*

- 3.1.1** *borehole*—a hole of circular cross-section made in soil or rock to ascertain the nature of the subsurface materials. Normally, a borehole is advanced using an auger, a drill, or casing with or without drilling fluid.
- 3.1.2** *earth material*—soil, bedrock, or fill.
- 3.1.3** *ground-water level*—the level of the water table surrounding a borehole or well. The ground-water level can be represented as an elevation or as a depth below the ground surface.
- 3.1.4** *liquid level*—the level of liquid in a borehole or well at a particular time. The liquid level can be reported as an elevation or as a depth below the top of the land surface. If the liquid is ground water it is known as water level.
- 3.1.5** *monitoring well (observation well)*—a special well drilled in a selected location for observing parameters such as liquid level or pressure changes or for collecting liquid samples. The well may be cased or uncased, but if cased the casing should have openings to allow flow of borehold liquid into or out of the casing.
- 3.1.6** *stabilized borehole liquid level*—the borehole liquid level which remains essentially constant with time, that is, liquid does not flow into or out of the borehole.
- 3.1.7** *top of borehole*—the surface of the ground surrounding the borehole.
- 3.1.8** *water table (ground-water table)*—the surface of a ground-water body at which the water pressure equals atmospheric pressure. Earth material below the ground-water table is saturated with water.

² *Annual Book of ASTM Standards*, Vol 04.08.

3.2 Definitions:

3.2.1 For definitions of other terms used in this test method, see Terminology D653.

4.0 Significance and Use

4.1 In geotechnical, hydrologic, and waste-management investigations, it is frequently desirable, or required, to obtain information concerning the presence of ground water or other liquids and the depths to the ground-water table or other liquid surface. Such investigations typically include drilling of exploratory boreholes, performing aquifer tests, and possibly completion as a monitoring or observation well. The opportunity exists to record the level of liquid in such boreholes or wells, as the boreholes are being advanced and after their completion.

4.2 Conceptually, a stabilized borehole liquid level reflects the pressure of ground water or other liquid in the earth material exposed along the sides of the borehole or well. Under suitable conditions, the borehole liquid level and the ground-water, or other liquid, level will be the same, and the former can be used to determine the latter. However, when earth materials are not exposed to a borehole, such as material which is sealed off with casing or drilling mud, the borehole water levels may not accurately reflect the ground-water level. Consequently, the user is cautioned that the liquid level in a borehole does not necessarily bear a relationship to the ground-water level at the site.

4.3 The user is cautioned that there are many factors which can influence borehole liquid levels and the interpretation of borehole liquid-level measurements. These factors are not described or discussed in this test method. The interpretation and application of borehole liquid-level information should be done by a trained specialist.

4.4 Installation of piezometers should be considered where complex ground-water conditions prevail or where changes in intergranular stress, other than those associated with fluctuation in water level, have occurred or are anticipated.

5.0 Apparatus

5.1 Apparatus conforming to one of the following shall be used for measuring borehole liquid levels.

5.1.1 *Weighted Measuring Tape*—A measuring tape with a weight attached to the end. The tape shall have graduations that can be read to the nearest 0.01 ft. The tape

shall not stretch more than 0.05% under normal use. Steel surveying tapes in lengths of 50, 100, 200, 300, and 500 ft. (20, 30, 50 or 100 m) and widths of ¼ in. (6mm) are commonly used. A black metal tape is better than a chromium-plated tape. Tapes are mounted on hand-cranked reels up to 500 ft (100m) lengths. Mount a slender weight, made of lead, to the end of the tape to ensure plumbness and to permit some feel for obstructions. Attach the weight to the tape with wire strong enough to hold the weight but not as strong as the tape. This permits saving the tape in the event the weight becomes lodged in the well or borehole. The size of the weight shall be such that its displacement of water causes less than a 0.05-ft (15-mm) rise in the borehole water level, or a correction shall be made for the displacement. If the weight extends beyond the end of the tape, a length correction will be needed in measurement Procedure C (see 7.2.3).

5.1.2 *Electrical Measuring Device*—A cable or tape with electrical wire encased, equipped with a weighted sensing tip on one end and an electric meter at the other end. An electric circuit is completed when the tip contacts water; this is registered on the meter. The cable may be marked with graduations similar to a measuring tape (as described in 5.1.1).

5.1.3 *Other Measuring Devices*—A number of other recording and non-recording devices may be used. See Ref. (1) for more details³.

6.0 Calibration and Standardization

6.1 Calibrate measuring apparatus in accordance with the manufacturers' directions.

7.0 Procedure

7.1 Liquid-level measurements are made relative to a reference point. Establish and identify a reference point at or near the top of the borehole or a well casing. Determine and record the distance from the reference point to the top of the borehole (land surface). If the borehole liquid level is to be reported as an elevation, determine the elevation of the reference point or the top of borehole (land surface). Three alternative measurement procedures (A, B, and C) are described.

Note 1---In general, Procedure A allows for greater accuracy than B or C, and B allows for greater accuracy than C; other procedures have a variety of accuracies that must be determined from the referenced literature (2-5).

7.2 *Procedure A—Measuring Tape:*

7.2.1 Chalk the lower few feet of tape by drawing the tape across a piece of colored carpenter's chalk.

7.2.2 Lower a weighted measuring tape slowly into the borehole or well until the liquid surface is penetrated. Observe and record the reading on the tape at the reference point. Withdraw the tape from the borehole and observe the lower end of the tape. The demarcation between the wetted and unwetted portions of the chalked tape should be apparent. Observe and record the reading on the tape at that point. The difference between the two readings is the depth from the reference point to the liquid level.

Note 2—Submergence of the weight and tape may temporarily cause a liquid-level rise in wells or boreholes having very small diameters. This effect can be significant if the well is in materials of very low hydraulic conductivity.

Note 3—Under dry surface conditions, it may be desirable to pull the tape from the well or borehole by hand, being careful not to allow it to become kinked, and reading the liquid mark before rewinding the tape onto the reel. In this way, the liquid mark on the chalked part of the tape is rapidly brought to the surface before the wetted part of the tape dries. In cold regions, rapid withdrawal of the tape from the well is necessary before the wet part freezes and becomes difficult to read. The tape must be protected if rain is falling during measurements.

Note 4—In some pumped wells, or in contaminated wells a layer of oil may float on the water. If the oil layer is only a foot or less thick, read the tape at the top of the oil mark and use this reading for the water-level measurement. The measurement will not be greatly in error because the level of the oil surface in this case will differ only slightly from the level of the water surface that would be measured if no oil was present. If several feet of oil are present in the well, or if it is necessary to know the thickness of the oil layer, a water-detector paste for detecting water in oil and gasoline storage tanks is available commercially. The paste is applied to the lower end of the tape that is submerged in the well. It will show the top of the oil as a wet line and the top of the water as a distinct color change.

7.2.3 As a standard of good practice, the observer should make two measurements. If two measurements of static liquid level made within a few minutes do not agree within about 0.01 or 0.02 ft (generally regarded as the practical limit of precision) in boreholes or wells having a depth to liquid of less than a couple of hundred feet, continue to measure until the reason for the lack of agreement is determined or until the results are shown to be reliable. Where water is dripping into the hole or covering its wall, it may be impossible to get a good water mark on the chalked tape.

7.2.4 After each well measurement, in areas where polluted liquids or ground water is suspected, decontaminate that part of the tape measure that was wetted to avoid contamination of other wells.



7.3 *Procedure B—Electrical Measuring Device:*

7.3.1 Check proper operation of the instrument by inserting the tip into water and noting if the contact between the tip and the water surface is registered clearly.

Note 5—In pumped wells having a layer of oil floating on the water, the electric tape will not respond to the oil surface and, thus, the liquid level determined will be different than would be determined by a steel tape. The difference depends on how much oil is floating on the water. A miniature float-driven switch can be put on a two-conductor electric tape that permits detection of the surface of the uppermost fluid.

GEOLIS™ LOCATION IDENTIFICATION FORM

GEOLIS Location Identification Form

CLIENT: _____ PROJECT NAME / No.: _____ PROJECT LOCATION: _____ SITE NAME / No.: _____ BOREHOLE / WELL ID: _____ BEGIN DATE: _____ END DATE: _____ LOGGER: _____		QUALITY LEVEL: 1 - 2 - 3 UNIT SYSTEM: ENGLISH - METRIC	
LOCATION TYPE: BOR - PIZ - WEL - PIT - _____ TEST PIT: LENGTH: _____ FT/M WIDTH: _____ FT/M BEDROCK CONFIRMED: NOT - SUS - SPS - AUG - COR - CUT TOTAL DEPTH: _____ FT/M BGS DEPTH TO BEDROCK: _____ FT/M BGS BOREHOLE DIAMETER No.1: _____ IN/CM INTERVAL: _____ TO _____ FT/M BGS METHOD: HSA SSA BKA JET DRT RRT COR DAW CBT DCD DHH OTHER: _____ FLUID: AIR - WATER - MUD - FOAM - NONE		SITE SKETCH 	
BOREHOLE DIAMETER No.2: _____ IN/CM INTERVAL: _____ TO _____ FT/M BGS METHOD: HSA SSA BKA JET DRT RRT COR DAW CBT DCD DHH OTHER: _____ FLUID: AIR - WATER - MUD - FOAM - NONE			SURFACE ELEVATION: _____ N. COORDINATE: _____ E. COORDINATE: _____ WELL PERMIT No.: _____
BOREHOLE DIAMETER No.3: _____ IN/CM INTERVAL: _____ TO _____ FT/M BGS METHOD: HSA SSA BKA JET DRT RRT COR DAW CBT DCD DHH OTHER: _____ FLUID: AIR - WATER - MUD - FOAM - NONE		HOLE ABANDONED ? YES - NO (IF YES DESCRIBE IN COMMENTS) WELL INSTALLED ? YES - NO WELL CLUSTER ? YES - NO No. OF WELLS: _____ WELL NEST ? YES - NO No. OF WELLS: _____	
DRILLING COMPANY: _____ DRILLER: _____ DRILL RIG TYPE: _____		PUMPS INSTALLED ? YES - NO PURGE: _____ TYPE _____ DEPTH _____ SAMPLE: _____	
COMMENTS: _____ _____ _____ _____		BOREHOLE TESTING BOREHOLE GEOPHYSICS ? YES - NO SLUG TESTS ? YES - NO PACKER TESTS ? YES - NO PUMPING TESTS ? YES - NO	
DATA ENTRY BY: _____ DATE ENTERED: _____ QC REPORTS PRINTED ? YES - NO		QC REVIEW BY: _____ REVIEW DATE: _____ APPROVED WITH - WITHOUT REVISIONS	QA REVIEW BY: _____ REVIEW DATE: _____ APPROVED WITH - WITHOUT REVISIONS

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FIG. 1 Example of a GEOLIS™ LOCATION IDENTIFICATION FORM

FIG. 2 Example of a GEOLIS_{TM} WATER LEVEL FORM

[illegible]

- 7.3.2 Dry the tip. Slowly lower the tip into the borehole or well until the meter indicates that the tip has contacted the surface of the liquid.
- 7.3.3 For devices with measurement graduations on the cable, note the reading at the reference point. This is the liquid-level depth below the reference point of the borehole or well.
- 7.3.4 For measuring devices without graduations on the cable, mark the cable at the reference point. Withdraw the cable from the borehole or well. Stretch out the cable and measure and record the distance between the tip and the mark on the cable by use of a tape. This distance is the liquid-level depth below the reference point.
- 7.3.5 A second or third check reading should be taken before withdrawing the electric tape from the borehole or well.
- 7.3.6 Decontaminate the submerged end of the electric tape or cable after measurements in each well.

Note 6—The length of the electric line should be checked by measuring with a steel tape after the line has been used for a long time or after it has been pulled hard in attempting to free the line. Some electric lines, especially the single line wire, are subject to considerable permanent stretch. In addition, because the probe is usually larger in diameter than the wire, the probe can become lodged in a well. Sometimes the probe can be attached by twisting the wires together by hand and using only enough electrical tape to support the weight of the probe. In this manner, the point of probe attachment is the weakest point of the entire line. Should the probe become "hung in the hole," the line may be pulled and breakage will occur at the probe attachment point, allowing the line to be withdrawn.

7.4 *Procedure C—Measuring Tape and Sounding Weight:*

- 7.4.1 Lower a weighted measuring tape into the borehole or well until the liquid surface is reached. This is indicated by an audible splash and a noticeable decrease in the downward force on the tape. Observe and note the reading on the tape at the reference point. Repeat this process until the readings are consistent to the accuracy desired. Record the result as the liquid-level depth below the reference point.

Note 7—The splash can be made more audible by using a "plover," a lead weight with a concave bottom surface.

- 7.4.2 If the liquid level is deep, or if the measuring tape adheres to the side of the borehole, or for other reasons, it may not be possible to detect the liquid surface using this method. If so, use Procedure A or Procedure B.

8.0 **Determination of a Stabilized Liquid Level**

- 8.1** As liquid flows into or out of the borehole or well, the liquid level will approach, and may reach, a stabilized level. The liquid level then will remain essentially constant with time.

Note 8—The time required to reach equilibrium can be reduced by removing or adding liquid until the liquid level is close to the estimated stabilized level.

- 8.2** Use one of the following two procedures to determine the stabilized liquid level.

- 8.2.1** *Procedure 1*—Take a series of liquid measurements until the liquid level remains constant with time. As a minimum, two such constant readings are needed (more readings are preferred). The constant reading is the stabilized liquid level for the borehole or well.

Note 9—If desired, the time and level data could be plotted on graph paper in order to show when equilibrium is reached.

- 8.2.2** *Procedure 2* --- Take at least three liquid-level measurements at approximately equal time intervals as the liquid level changes during the approach to a stabilized liquid level.

- 8.2.2.1** The approximate position of the stabilized liquid level in the well or borehole is calculated using the following equation:

$$h_0 = \frac{y_1^2}{y_1 y_2}$$

where:

h_0 = distance the liquid level must change to reach the stabilized liquid level,
 y_1 = distance the liquid level changed during the time interval between the first two liquid-level readings, and
 y_2 = distance the liquid level changed during the time interval between the second and the third liquid level readings.

- 8.2.2.2** Repeat the above process using successive sets of three measurements until the h_0 computed is consistent to the accuracy desired. Compute the stabilized liquid level in the well or borehole.

Note 10—The time span required between readings for Procedures 1 and 2 depends on the permeability of

the earth material. In material with comparatively high permeability (such as sand), a few minutes may be sufficient. In materials with comparatively low permeability (such as clay), many hours or days may be needed. The user is cautioned that in clayey soils the liquid in the borehole or well may never reach a stabilized liquid level equivalent to the level in the earth materials surrounding the borehole or well.

9.0 Report

9.1 For borehole or well liquid-level measurements, report, as a minimum, the following information:

9.1.1 Borehole or well identification.

9.1.2 Description of reference point.

9.1.3 Distance between reference point and top borehole or land surface.

9.1.4 Elevation of top of borehole or reference point (if the borehole or well liquid level is reported as an elevation).

9.1.5 Description of measuring device used, and graduation.

9.1.6 Procedure of measurement.

9.1.7 Date and time of reading.

9.1.8 Borehole or well liquid level.

9.1.9 Description of liquid in borehole or well.

9.1.10 State whether borehole is cased, uncased, or contains a monitoring (observation) well standpipe and give description of, and length below top of borehole of, casing or standpipe.

9.1.1.1 Drilled depth of borehole, if known.

9.2 For determination of stabilized liquid level, report:

9.2.1 All pertinent data and computations.

9.2.2 Procedure of determination.

9.2.3 The stabilized liquid level.

9.3 *Report Forms*—An example of a GEOLIS Location Identification form is shown

in Fig. 1. An example of a GEOLIS Water Level form, for recording continuing measurements for a borehole or well, is shown in Fig. 2.

10.0 Precision and Bias

10.1 Borehole liquid levels shall be measured and recorded to the accuracy desired and consistent with the accuracy of the measuring device and procedures used. Procedure A multiple measurements by wetted tape should agree within 0.02 ft (6 mm). Procedure B multiple measurements by electrical tape should agree within 0.04 ft (12 mm). Procedure C multiple measurements by tape and sounding weight should agree within 0.04 ft (12 mm). Garber and Koopman (2) describe corrections that can be made for effects of thermal expansion of tapes or cables and of stretch due to the suspended weight of tape or cable and plumb weight when measuring liquid levels at depths greater than 500 ft (150 m).

11.0 References

- (1) *National Handbook of Recommended Method for Water Data Acquisition---Chapter 2---Ground Water*" Office of Water Data Coordination, Washington, DC, 1980.
- (2) Garber, M.S., and Koopman, F.C., "Methods of Measuring Water Levels in Deep Wells, *U.S. Geologic Survey Techniques for Water Resources Investigations*, Book 8, Chapter A-1, 1968.
- (3) Hvorslev, M. J., "Ground Water Observations," in *Subsurface Exploration and Sampling of Soils for Civil Engineering Purposes*. American Society Civil Engineers, New York, NY 1949.
- (4) Zegarra, E.J., "Suggested Method for Measuring Water Level in Boreholes," *Special Procedures for Testing Soil and Rock for Engineering Purposes*, ASTM STP 479, ASTM, 1970.
- (5) "Determination of Water Level in a Borehole," CSA Standard A 119.6 - 1971, Canadian Standards Association, 1971.

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SUPERFUND TECHNICAL ASSESSMENT RESPONSE TEAM
STANDARD OPERATING PROCEDURE

SOP 101
LOGBOOK DOCUMENTATION

1.0 INTRODUCTION

The purpose of this Standard Operating Procedure (SOP) is to provide Roy F. Weston, Inc. (WESTON®), Superfund Technical Assessment Response Team (START) members with a step-by-step guide for logbook documentation. Note: A factual and objective record of contractor and safety activities is critical for future litigation.

2.0 LOGBOOKS

2.1 Personal Logbooks

All START members are required to document daily office activities in personal logbooks. Information in these logbooks shall be factual and objective and must be kept current at all times. Entries should include daily events, such as specific technical directive document (TDD) activities, task numbers, phone calls and meetings. It is important to note that all personal logbooks are property of WESTON® and may be reviewed by management at any time.

2.2 Site Logbooks

All START members are required to document site activities in site logbooks which are required of all active U.S. Environmental Protection Agency (EPA) removal/enforcement sites. Information in these logbooks shall be factual and objective and must be kept current at all times. Entries should include daily events, such as site activities, safety meetings, names of personnel entering/exiting site, sampling data, etc. All site logbooks are the property of EPA and must remain with the site file. Site logbooks will be maintained by the Site Leader. Information may be entered into the site logbook by the appropriate team member. Entries will be made in waterproof ink.

3.0 SPECIFIC PROTOCOL

Adhere to the following protocol for both personal and site logbooks:

1. Print the site name, volume number, and coverage dates on the site logbook cover and inside cover in black ink.
2. Write the author's name and volume number on the personal logbook cover and

- inside cover.
3. Write Roy F. Weston, Inc., as well as the mailing address and phone number on the inside covers of both the site and personal logbooks.
 4. Write in between margins only.
 5. Fill in all pages in all logbooks.
 6. Place a single line through mistakes and initial each one.
 7. Make sure that the logbook pages are pre-numbered, or number each page when a new logbook is received.
 8. Write late notes/entries as soon as possible and identify this entry as such.
 9. Be objective for all logbook entries.

Personal logbooks will contain the following information:

1. Employee's name, work address, and telephone number.
2. Full names and affiliations for all persons cited in the logbook. *Be sure to check the spelling of names and affiliations for accuracy.*
3. Sequence of daily events.
4. Task numbers, full dates (i.e. 12 January 2002), and military time (i.e. 0800).
5. Initialed daily entries.

Site logbooks will contain the following information:

1. The name and location of the site.
2. Dates of sample collection or event.
3. Time of sample collection or event.
4. Field observations.
5. Numbers and types of samples collected and sample identification numbers.
6. Description of sampling methodology by referenced Standard Operating Procedures.
7. Type(s) of laboratory analyses requested.
8. Phone calls and/or contacts with people at the site on a daily basis.
9. Name of subcontractor and excavation equipment.
10. Any modifications in work activities, i.e., sampling locations and reasons.
11. Visual description of samples and test pits as required. Includes color, texture, moisture, and other physical soil characteristics.
12. Names of Site Leader and Assistant Site Leaders.
13. Site sketches if appropriate. Draw a box around the sketch to separate the sketch from the text in the logbook.
14. Levels of personal protective equipment worn for tasks performed.
15. Weather conditions on a daily basis.
16. Significant changes during the day (i.e., stoppage of work during a lightning storm).

4.0 REFERENCES

WESTON® (Roy F. Weston, Inc.). 1993. *Standard Operating Practices (SP) Manual*. SP No. 16-11-016, "Test Pit Excavation and Sampling". West Chester, PA.



PHOTOIONIZATION DETECTOR (PID) HNU

SOP#: 2114
DATE: 10/06/94
REV. #: 0.0

1.0 SCOPE AND APPLICATION

The purpose of this Standard Operating Procedure (SOP) is to describe the procedure for using a photoionization detector (PID). The PID is a portable, nonspecific, vapor/gas detector employing the principle of photoionization to detect a variety of chemical compounds, both organic and inorganic, in air. This procedure is applicable to the HNU PI-101, HNU ISPI-101, and HW-101 used for air monitoring.

These are standard (i.e., typically applicable) operating procedures which may be varied or changed as required, dependent on site conditions, equipment limitations or limitations imposed by the procedure. In all instances, the ultimate procedures employed should be documented and associated with the final report.

Mention of trade names or commercial products does not constitute U.S. Environmental Protection Agency (U.S. EPA) endorsement or recommendation for use.

2.0 METHOD SUMMARY

The PID is a useful general survey instrument at hazardous waste sites. A PID is capable of detecting and measuring real-time concentrations of many organic and inorganic vapors in air. A PID is similar to a flame ionization detector (FID) in application; however, the PID has somewhat broader capabilities in that it can detect certain inorganic vapors. Conversely, the PID is unable to respond to certain low molecular weight hydrocarbons, such as methane and ethane, that are readily detected by FID instruments.

The PID employs the principle of photoionization. The analyzer will respond to most vapors that have an ionization potential less than or equal to that supplied by the ionization source, which is an ultraviolet (UV) lamp. Photoionization occurs when an atom or molecule absorbs a photon of sufficient energy to

release an electron and form a positive ion. This will occur when the ionization potential of the molecule in electron volts (eV) is less than the energy of the photon. The sensor is housed in a probe and consists of a sealed ultraviolet light source that emits photons with an energy level high enough to ionize many trace organics, but not enough to ionize the major components of air (e.g., nitrogen, oxygen, carbon dioxide). The ionization chamber exposed to the light source contains a pair of electrodes, one a bias electrode, and the second the collector electrode. When a positive potential is applied to the bias electrode, an electro-magnetic field is created in the chamber. Ions formed by the adsorption of photons are driven to the collector electrode. The current produced is then measured and the corresponding concentration displayed on a meter, directly, in units above background. Several probes are available for the PID, each having a different eV lamp and a different ionization potential. The selection of the appropriate probe is essential in obtaining useful field results. Though it can be calibrated to a particular compound, the instrument cannot distinguish between detectable compounds in a mixture of gases and, therefore, indicates an integrated response to the mixture.

Three probes, each containing a different UV light source, are available for use with the HNU. Energies are 9.5, 10.2, and 11.7 eV. All three detect many aromatic and large molecular hydrocarbons. The 10.2 eV and 11.7 eV probes, in addition, detect some smaller organic molecules and some halogenated hydrocarbons. The 10.2 eV probe is the most useful for environmental response work, as it is more durable than the 11.7 eV probe and detects more compounds than the 9.5 eV probe.

Gases with ionization potentials near to or less than that of the lamp will be ionized. These gases will thus be detected and measured by the analyzer. Gases with ionization potentials higher than that of the lamp will not be detected. Ionization potentials for various atoms, molecules, and compounds are given in

Table 1 (Appendix A). The ionization potential of the major components of air, oxygen, nitrogen, and carbon dioxide, range from about 12.0 eV to about 15.6 eV and are not ionized by any of the three lamps.

Table 2 (Appendix A) illustrates ionization sensitivities for a large number of individual species when exposed to photons from a 10.2 eV lamp. Applications of each probe are included in Table 3 (Appendix A).

While the primary use of the HNU is as a quantitative instrument, it can also be used to detect certain contaminants, or at least to narrow the range of possibilities. Noting instrument response to a contaminant source with different probes can eliminate some contaminants from consideration. For instance, a compound's ionization potential may be such that the 9.5 eV probe produces no response, but the 10.2 eV and 11.7 eV probes do elicit a response.

3.0 SAMPLE PRESERVATION, CONTAINERS, HANDLING, AND STORAGE

This section is not applicable to this SOP.

4.0 INTERFERENCES AND POTENTIAL PROBLEMS

4.1 PID Instrument Limitations

1. The PID is a nonspecific total vapor detector. It cannot be used to identify unknown substances; it can only roughly quantify them.
2. The PID must be calibrated to a specific compound.
3. The PID does not respond to certain low molecular weight hydrocarbons, such as methane and ethane. In addition, the HNU does not detect a compound if the probe has a lower energy than the compound's ionization potential.
4. Certain toxic gases and vapors, such as carbon tetrachloride and hydrogen cyanide, have high ionization potentials and cannot be detected with a PID.

5. Certain models of PID instruments are not intrinsically safe. The HNU PI-101 and HW-101 are not designed for use in potentially flammable or combustible atmospheres. Therefore, these models should be used in conjunction with a Combustible Gas Indicator. The ISPI-101 is intrinsically safe, however.
6. Electrical power lines or power transformers may cause interference with the instrument and thus cause measurement errors. Static voltage sources such as power lines, radio transmissions, or transformers may also interfere with measurements.
7. High winds and high humidity will affect measurement readings. The HNU may become unusable under foggy or humid conditions. An indication of this is the needle dropping below zero, or a slow constant climb on the read-out dial.
8. The lamp window must be periodically cleaned to ensure ionization of the new compounds by the probe (i.e., new air contaminants).
9. The HNU measures concentrations from about 1-2000 ppm, although the response is not linear over this entire range. For example, if calibrated to benzene, the response is linear from about 0-600 units above background. This means the HNU reads a true concentration of benzene only between 0 and 600. Greater concentrations are detected at a lower level than the true value.
10. This instrument is not to be exposed to precipitation (rain). The units are not designed for this service.
11. Do not use this instrument for head space analysis where liquids can inadvertently be drawn into the probe.

4.2 Regulatory Limitations

Transport of calibration gas cylinders by passenger and cargo aircraft must comply with International Air Transport Association (IATA) Dangerous Goods

Regulations or the U.S. Code of Federal Regulations, 49 CFR Parts 100-177. A typical calibration gas included with a PID is isobutylene. It is classified as a non-flammable gas, UN #1556 and the proper shipping name is Compressed Gas. It must be shipped by cargo aircraft only.

5.0 EQUIPMENT/APPARATUS

The following equipment is required for PID operation:

- C PID (HNU)
- C Operating manual
- C Probes: 9.5 eV, 10.2 eV, or 11.7 eV
- C Battery charger for PID
- C Spare batteries
- C Jeweler's screwdriver for adjustments
- C Tygon tubing
- C NBS traceable calibration gas
- C "T" valve for calibration
- C Field Data Sheets/Site Logbook
- C Intake assembly extension
- C Strap for carrying PID
- C Teflon tubing for downhole measurements
- C Plastic bags for protecting the PID from moisture and dirt

Note: Battery charge status - This instrument may be kept on continuous charge without battery damage.

6.0 REAGENTS

- C Isobutylene standards for calibration
- C Benzene reference standard
- C Methanol for cleaning ionization chamber (GC grade)
- C Mild soap solution for cleaning unit surfaces
- C Specific gas standards when calibrating to a specific compound
- C Light source cleaning compound Cat. No. PA101534-A1 (For use only with 9.5 and 10.2 lamps)

The HNU is calibrated in accordance with the operations manual using isobutylene as the calibration standard. The operations manual may also be referred to for alternate calibration to a specific compound.

7.0 PROCEDURES

7.1 Preparation

Check out and ensure the proper operation of the PID, as appropriate, using the equipment checklist provided in Sections 5.0 and 6.0 and the steps listed below.

7.2 Start-Up Procedures

1. Allow the temperature of the unit to equilibrate to its surrounding. This should take about five minutes.
2. Attach the probe to the read-out unit. Match the alignment key, then twist the connector clockwise until a distinct locking is felt. Make sure the microswitch (red button) is depressed by the locking ring.
3. Turn the FUNCTION switch to the battery check position. Check to ensure that the indicator reads within or beyond the green battery arc on the scale plate. If the indicator is below the green arc, or if the red LED comes on, the battery must be charged prior to using.
4. To zero the instrument, turn the FUNCTION switch to the STANDBY position and rotate the ZERO POTENTIOMETER until the meter reads zero. Wait 15-20 seconds to ensure that the zero adjustment is stable; if not, then readjust.
5. Check to see that the SPAN POTENTIOMETER is set at the appropriate setting for the probe being used (i.e., 9.8 for the 10.2 eV probe, 5.0 for the 11.7 eV probe, 1 for the 9.5 eV probe. Note: The setting may vary based on the intensity of the light source).
6. Set the FUNCTION switch to the desired range (i.e., 0-20, 0-200, 0-2000).
7. Listen for the fan operation to verify fan function.

8. Look for ultraviolet light source in the probe to verify function. Do not look at light source from closer than six inches with unprotected eyes, observe only briefly.
9. Check instrument with an organic point source, such as a magic marker, prior to survey to verify instrument function.
10. Routinely during the day, verify the useful battery life by turning the function switch to BATT and schedule the instrument's use accordingly.

7.3 Field Operation

7.3.1 Field Calibration

1. Follow the start-up procedure in Section 7.2.
2. Set the FUNCTION switch to the range setting which includes the concentration of the calibration gas.
3. Attach a regulator to a disposable cylinder of calibration gas. Connect the regulator to the probe of the HNU with a piece of clean tygon tubing. Open the valve on the regulator.
4. After 15 seconds, the meter reading should equal the response value as indicated on the calibration gas cylinder used. If the reading is within $\pm 15\%$ of the response value, then the instrument can be field calibrated to the response value using the external SPAN ADJUSTMENT control. The SPAN ADJUSTMENT control should be adjusted to a lower setting until the correct reading has been obtained. The lower the number on the SPAN ADJUSTMENT control, the greater the instrument sensitivity. If the SPAN ADJUSTMENT control has to be adjusted below a setting of 4.00, the unit should be red-tagged and returned for repairs.
5. If the meter reading is greater than $\pm 15\%$ of the response value of the calibration gas used, then the instrument should be red-tagged and returned for re-calibration.

6. Record the following information in the site logbook: the instrument ID number (U.S. EPA decal or serial number if the instrument is a rental), the initial and final span settings, the date and time, concentration and type of calibration gas used, and the name of the person who field calibrated the instrument.
7. If the PID does not start up, check out, or calibrate properly, the instrument should not be used. Under no circumstances is work requiring air monitoring with a PID to be done without a proper functioning instrument.
8. In some field applications, with the exception of the probe's inlet and exhaust, the PID should be wrapped in clear plastic to prevent it from becoming contaminated and to prevent water from getting inside in the event of precipitation.

7.3.2 Operation

1. All readings are to be recorded in the site logbook. Readings should be recorded, following background readings, as "units above background," not ppm.
2. As with any field instrument, accurate results depend on the operator being completely familiar with the operator's manual. The instructions in the operating manual should be followed explicitly in order to obtain accurate results.
3. Position the probe assembly close to the area to be monitored because the low sampling rate allows for only very localized readings. Under no circumstances should the probe tip assembly be immersed in fluid.
4. While taking care to prevent the PID from being exposed to excessive moisture, dirt, or contamination, monitor the work activity as specified in the site Health and Safety Plan. The PID survey should be conducted at a slow to moderate rate of speed and the intake assembly (the probe) slowly swept from side to side. There is a three to five second delay in read-out depending upon the instruments sensitivity to the contaminant.

5. During drilling activities, PID monitoring is performed at regular intervals downhole, at the headspace, and in the breathing zone. In addition, where elevated organic vapor levels are encountered, monitoring may be performed in the breathing zone during actual drilling. When the activity being monitored is other than drilling, readings should emphasize breathing zone conditions.
6. When the activity is completed or at the end of the day, carefully clean the outside of the PID with a damp disposable towel to remove any visible dirt.

7.4 Post Operation

1. Turn FUNCTION Switch to OFF.
2. Return the PID to a secure area and check the calibration (Section 7.3.1.) before charging. Connect the instrument to charger and plug in the charger. The probe must be connected to the readout unit to charge the HNU.
3. Complete logbook entries, verifying the accuracy of entries and signing/initialing all pages. Following completion of a series of "0" readings, verify the instrument is working as in Section 7.3.1.
4. Check the equipment, repair or replace damaged equipment, and charge the batteries.

7.5 Equipment Calibration

1. Follow the start-up procedure in Section 7.2.
2. Set the FUNCTION switch to the range setting which includes the concentration of the calibration gas.
3. Attach a regulator to a cylinder of calibration gas. Connect the regulator to the probe of the NHU with a piece of clean tygon tubing. Open the valve on the regulator.
4. After 15 seconds, the meter reading should equal the response value as indicated on the calibration gas cylinder used. If the reading is greater than $\pm 15\%$ of the actual

concentration, an internal calibration is necessary. Unlock the SPAN POTENTIOMETER dial before adjusting it. Adjust the SPAN POTENTIOMETER to the span setting recommended for the probe being used (i.e., 9.8 for the 10.2 eV probe, 5.0 for the 11.7 eV probe, 1 for the 9.5 eV probe). To calibrate the instrument, unscrew the bottom support screw and lift the instrument out of the case. Locate and adjust the trimpot "R-32" (near the top of the printed circuit board) by inserting a small screwdriver and gently turning. When the instrument gives the correct reading for the calibration gas being used, reassemble it.

5. Record the following information in the calibration logbook: the instrument identification number (U.S. EPA barcode number or serial number if the instrument is a rental), the initial and final span settings, the date and time, concentration and type of calibration gas used, and the name of the person who calibrated the instrument. Affix a sticker to the instrument indicating the person who performed the calibration, the date of calibration, and the due date of the next calibration.
6. Turn the FUNCTION switch to OFF and connect the instrument to the charger. The probe must be connected to the readout unit to ensure that the unit accepts a charge.

8.0 CALCULATIONS

The HNU is a direct reading instrument. Readings are interpreted as units above background rather than ppm.

9.0 QUALITY ASSURANCE/ QUALITY CONTROL

There are no specific quality assurance activities which apply to the implementation of these procedures. However, the following general QA procedures apply:

1. All data must be documented on field data sheets or within site logbooks.
2. All instrumentation must be operated in

accordance with operating instructions as supplied by the manufacturer, unless otherwise specified in the work plan. Equipment checkout and calibration activities must occur prior to sampling/operation, and they must be documented.

10.0 DATA VALIDATION

This section is not applicable to this SOP.

11.0 HEALTH AND SAFETY

When working with potentially hazardous materials, follow U.S. EPA, OSHA, or corporate health and safety practices.

The HNU is certified by OSHA standards for use in Class 1, Division 2, Groups A, B, C, and D locations.

12.0 REFERENCES

HNU Systems, Inc. 1975. "Instruction Manual for Model PI-101 Photoionization Analyzer."

U.S. Code of Federal Regulations, 49 CFR Parts 100 to 177, Transportation, revised November 1, 1985.

U.S. Environmental Protection Agency. 1984. "Characterization of Hazardous Waste Sites - A Methods Manual: Volume II, Available Sampling Methods, Second Edition", EPA-600/4-84-076, Environmental Monitoring Systems Laboratory, Office of Research and Development, Las Vegas, Nevada.

International Air Transport Association Dangerous Goods Regulations

APPENDIX A

Tables

TABLE 1. Ionization Potentials

<u>SOME ATOMS AND SIMPLE MOLECULES</u>				<u>PARAFFINS AND CYCLOPARAFFINS</u>	
Molecule	IP(Ev)	Molecule	IP (eV)	Molecule	IP (eV)
H	13.595	I ₂	9.28	Methane	12.98
C	11.264	HF	15.77	Ethane	11.65
N	14.54	HCl	12.74	Propane	11.07
O	13.614	HBr	11.62	n-Butane	10.63
Si	8.149	HI	10.38	I-Butane	10.57
S	10.357	SO ₂	12.34	n-Pentane	10.35
F	17.42	CO ₂	13.79	ii-Pentane	10.32
Cl	13.01	COS	11.18	2,2-Dimethylpropane	10.35
Br	11.84	CS ₂	10.08	n-Hexane	10.18
I	10.48	N ₂ O	12.90	2-Methylpentane	10.12
H ₂	15.426	NO ₂	9.78	3-Methylpentane	10.08
N ₂	15.580	O ₃	12.80	2,2-Dimethylbutane	10.06
O ₂	12.075	H ₂ O	12.59	2,3-Dimethylbutane	10.02
CO	14.01	H ₂ S	10.46	n-Heptane	10.08
CN	15.13	H ₂ Se	9.88	2,2,4-Trimethylpentane	9.86
NO	9.25	H ₂ Te	9.14	Cyclopropane	10.06
CH	11.1	HCN	13.91	Cyclopentane	10.53
OH	13.18	C ₂ N ₂	13.8	Cyclohexane	9.88
F ₂	15.7	NH ₃	10.15	Methylcyclohexane	9.85
Cl ₂	11.48	CH ₃	9.840		
Br ₂	10.55	CH ₄	12.98		

APPENDIX A (Cont'd)

Tables

TABLE 1. Ionization Potentials (Continued)

ALKYL HALIDES

Molecule	IP (eV)	Molecule	IP (eV)
HCl	12.74	1-bromo-2-methylpropane	10.09
Cl ₂	11.48	2-bromo-2-methylpropane	9.89
CH ₄	12.98	1-bromopentane	10.10
Methyl chloride	11.28	HI	10.38
Dichloromethane	11.35	I ₂	9.28
Trichloromethane	11.42	Methyl iodide	9.54
Tetrachloromethane	11.47	Diiodomethane	9.34
Ethyl chloride	10.98	Ethyl iodide	9.33
1,2-Dichloroethane	11.12	1-iodopropane	9.26
1,3-Dichloropropane	10.85	2-iodopropane	9.17
1-chlorobutane	10.67	1-iodobutane	9.21
2-chlorobutane	10.65	2-iodobutane	9.09
1-chloro-2-methylpropane	10.66	1-iodo-2-methylpropane	9.18
2-chloro-2-methylpropane	10.61	2-iodo-2-methylpropane	9.02
HBr	11.62	1-iodopentane	9.19
Br ₂	10.55	F ₂	15.7
Methyl bromide	10.53	HF	15.77
Dibromomethane	10.49	CFCl ₃ (Freon 11)	11.77
Tribromomethane	10.51	CF ₂ Cl ₂ (Freon 12)	12.31
CH ₂ BrCl	10.77	CF ₃ Cl (Freon 13)	12.91
CHBr ₂ Cl	10.59	CHClF ₂ (Freon 22)	12.45
Ethyl bromide	10.29	CF ₂ Br ₂	11.67
1,1-dibromoethane	10.19	CH ₃ CF ₂ Cl (Genetron 101)	11.98
1-bromo-2-chloroethane	10.63	CFCl ₂ CF ₂ Cl	11.99
1-bromopropane	10.18	CF ₃ CCl ₃ (Freon 113)	11.78
2-bromopropane	10.075	CFHBrCH ₂ Br	10.75
1,3-dibromopropane	10.07	CF ₂ BrCH ₂ Br	10.83
1-bromobutane	10.13	CF ₃ CH ₂ I	10.00
2-bromobutane	9.98	n-C ₃ F ₇ I	10.36
1-chloropropane	10.82	n-C ₃ F ₇ CH ₂ Cl	11.84
2-chloropropane	10.78	n-C ₃ F ₇ CH ₂ I	9.96
1,2-dichloropropane	10.87	CF ₂ Br ₂	11.07

APPENDIX A (Cont'd)

Tables

TABLE 1. Ionization Potentials (Continued)

ALIPHATIC ALCOHOL, ETHER, THIOL, AND SULFIDES

Molecule	IP (eV)
Water	12.59
Methyl alcohol	10.85
Ethyl alcohol	10.48
n-propyl alcohol	10.20
i-propyl alcohol	10.16
n-butyl alcohol	10.04
Dimethyl ether	10.00
Diemthyl ether	9.53
n-propyl ether	9.27
i-propyl ether	9.20
Hydrogen Sulfide	10.46
Methanethiol	9.440
Ethanethiol	9.285
1-propanethiol	9.195
1-butanethiol	9.14
Dimethyl sulfide	8.685
Ethyl methyl sulfide	8.55
Diethyl sulfide	8.430
di-n-propyl sulfide	8.30

ALIPHATIC ALDEHYDES AND KETONES

Molecule	IP (eV)
Carbon Dioxide	13.79
Formaldehyde	10.87
Acetaldehyde	10.21
Propionaldehyde	9.98
n-butyraldehyde	9.86
Isobutyraldehyde	9.74
n-valeraldehyde	9.82
Isovaleraldehyde	9.71
Acrolein	10.10
Crotonaldehyde	9.73
Benzaldehyde	9.53
Acetone	9.69
Methyl ethyl ketone	9.53
Methyl n-propyl ketone	9.39
Methyl i-propyl ketone	9.32
Diethyl ketone	9.32
Methyl n-butyl ketone	9.34
Methyl i-butyl ketone	9.30
3,3-dimethyl butanone	9.17
2-heptanone	9.33
Cyclopentanone	9.26
Cyclohexanone	9.14
2,3-butanedione	9.23
2,4-pentanedione	8.87

APPENDIX A (Cont'd)

Tables

TABLE 1. Ionization Potentials (Continued)

ALIPHATIC ACIDS AND ESTERS

Molecule	IP (eV)
Carbon Dioxide	13.79
Formic acid	11.05
Acetic acid	10.37
Propionic acid	10.24
n-butyric acid	10.16
Isobutyric acid	10.02
n-valeric acid	10.12
Methyl formate	10.815
Ethyl formate	10.61
n-propyl formate	10.54
n-butyl formate	10.50
Isobutyl formate	10.46
Methyl acetate	10.27
Ethyl acetate	10.11
n-propyl acetate	10.04
Isopropyl acetate	9.99
n-butyl acetate	10.01
Isobutyl acetate	9.97
Sec-butyl acetate	9.91
Methyl propionate	10.15
Ethyl propionate	10.00
Methyl n-butyrate	10.07
Methyl isobutyrate	9.98

ALIPHATIC AMINES AND AMIDES

Molecule	IP (eV)
Ammonia	10.15
Methyl amine	8.97
Ethyl amine	8.86
n-propyl amine	8.78
i-propyl amine	8.72
n-butyl amine	8.71
i-butyl amine	8.70
s-butyl amine	8.70
t-butyl amine	8.64
Dimethyl amine	8.24
Diethyl amine	8.01
Di-n-propyl amine	7.84
Di-i-propyl amine	7.73
Di-n-butyl amine	7.69
Trimethyl amine	7.82
Triethyl amine	7.50
Tri-n-propyl amine	7.23
Formamide	10.25
Acetamide	9.77
N-methyl acetamide	8.90
N,N-dimethyl formamide	9.12
N,N-dimethyl acetamide	8.81
N,N-diethyl formamide	8.89
N,N-diethyl acetamide	8.60

APPENDIX A (Cont'd)

Tables

TABLE 1. Ionization Potentials (Continued)

<u>OTHER ALIPHATIC MOLECULES WITH N ATOM</u>		<u>OLEFINS, CYCLO-OLEFINS, ACETYLENES</u>	
Molecule	IP (eV)	Molecule	IP (eV)
Nitromethane	11.08	Ethylene	10.515
Nitroethane	10.88	Propylene	9.73
1-nitropropane	10.81	1-butene	9.58
2-nitropropane	10.71	2-methylpropene	9.23
HCN	13.91	Trans-2-butene	9.13
Acetonitrile	12.22	Cis-2-butene	9.13
Propionitrile	11.84	1-pentene	9.50
n-butyronitrile	11.67	2-methyl-1-butene	9.12
Acrylonitrile	10.91	3-methyl-1-butene	9.51
3-butene-nitrile	10.39	3-methyl-2-butene	8.67
Ethyl nitrate	11.22	1-hexene	9.46
Methyl thiocyanate	10.065	1,3-butadiene	9.07
Ethyl thiocyanate	9.89	Isoprene	8.845
Methyl isothiocyanate	9.25	Cyclopentene	9.01
Ethyl isothiocyanate	9.14	Cyclohexene	8.945
		4-methylcyclohexene	8.91
		4-cinylcyclohexene	8.93
		Cyclo-octatetraene	7.99
		Acetylene	11.41
		Propyne	10.36
		1-butyne	10.18

APPENDIX A (Cont'd)

Tables

TABLE 1. Ionization Potentials (Continued)

SOME DERIVATIVES OF OLEFINS

Molecule	IP (eV)
Vinyl chloride	9.995
Cis-dichloroethylene	9.65
Trans-dichloroethylene	9.66
Trichloroethylene	9.45
Tetrachloroethylene	9.32
Vinyl bromide	9.80
1,2-dibromoethylene	9.45
tribromoethylene	9.27
3-chloropropene	10.04
2,3-dichloropropene	9.82
1-bromopropene	9.30
3-bromopropene	9.7
CF ₃ CCl=CClCF ₃	10.36
n-C ₅ F ₁₁ CF=CF ₂	10.48
Acrolein	10.10
Crotonaldehyde	9.73
Mesityl oxide	9.08
Vinyl methyl ether	8.93
Allyl alcohol	9.67
Vinyl acetate	9.19

HETEROCYCLIC MOLECULES

Molecule	IP (eV)
Furan	8.89
2-methyl furan	8.39
2-furaldehyde	9.21
Tetrahydrofuran	9.54
Dihdropyran	8.34
Tetrahydropyran	9.26
Thiophene	8.860
2-chlorothiophene	8.68
2-bromothiophene	8.63
Pyrrole	8.20
Pyridine	9.32
2-picoline	9.02
3-picoline	9.04
4-picoline	9.04
2,3-lutidine	8.85
2,4-lutidine	8.85
2,6-lutidine	8.85
Tribromoethylene	9.27

APPENDIX A (Cont'd)

Tables

TABLE 1. Ionization Potentials (Continued)

<u>AROMATIC COMPOUNDS</u>			
Molecule	IP (eV)	Molecule	IP (eV)
Benzene	9.245	Phenyl isothiocyanate	8.520
Toluene	8.82	Benzonitrile	9.705
Ethyl benzene	3.76	Nitrobenzene	9.92
n-propyl benzene	8.72	Aniline	7.70
i-propyl benzene	8.69	Fluoro-benzene	9.195
n-butyl benzene	8.69	Chloro-benzene	9.07
s-butyl benzene	8.68	Bromo-benzene	8.98
t-butyl benzene	8.68	Iodo-benzene	8.73
o-xylene	8.56	o-dichlorobenzene	9.07
m-xylene	8.56	m-dichlorobenzene	9.12
p-xylene	8.445	p-dichlorobenzene	8.94
Mesitylene	8.40	1-chloro-2-fluorobenzene	9.155
Durene	8.025	1-chloro-3-fluorobenzene	9.21
Styrene	8.47	1-bromo-4-fluorobenzene	8.99
o-methyl styrene	8.35	o-fluorotoluene	8.915
Ethynylbenzene	8.815	m-fluorotoluene	8.915
Napthalene	8.12	p-fluorotoluene	8.785
1-methylnapthalene	7.69	o-chlorotoluene	8.83
2-methylnapthalene	7.955	m-chlorotoluene	8.83
Biphenyl	8.27	p-chlorotoluene	8.70
Phenol	8.50	o-bromotoluene	8.79
Anisole	8.22	m-bromotoluene	8.81
Phenetole	8.13	p-bromotoluene	8.67
Benzaldehyde	9.53	o-iodotoluene	8.62
Acetophenone	9.27	m-iodotoluene	8.61
Benzenethiol	8.33	p-iodotoluene	8.50
Phenyl isocyanate	8.77	Benzotrifluoride	9.68
		o-fluorophenol	8.66

APPENDIX A (Cont'd)

Tables

TABLE 1. Ionization Potentials (Continued)

MISCELLANEOUS MOLECULES

Molecule	IP (eV)
Ethylene oxide	10.565
Propylene oxide	10.22
p-dioxane	9.13
Dimethoxymethane	10.00
Diethoxymethane	9.70
1,1-dimethoxyethane	9.65
Propiolactone	9.70
Methyl disulfide	8.46
Ethyl disulfide	8.27
Diethyl sulfite	9.68
Thiolacetic acid	10.00
Acetyl chloride	11.02
Acetyl bromide	10.55
cyclo-C ₆ H ₁₁ CF ₃	10.46
(n-C ₃ F ₇)(CH ₃)C=O	10.58
Trichlorovinylsilane	10.79
(C ₂ F ₅) ₃ N	11.7
Isoprene	9.08
Phosgene	11.77

APPENDIX A (Cont'd)

Tables

TABLE 2. Relative Photoionization Sensitivities for Gases

Chemical	Relative Sensitivity	Examples
Aromatic	10	Benzene, Toluene, Styrene
Aliphatic Acid	10	Diethylamine
Chlorinated Unsaturated	5-9	Vinyl Chloride, Vinylidene Chloride, Trichloroethylene
Carbonyl	7-9	MEK, MiBK, Acetone, Cyclohexanone
Unsaturated	3-5	Acrolein, Propylene, Cyclohexanone, Allyl Alcohol
Sulfide	3-5	Hydrogen Sulfide, Methyl Mercaptan
Paraffin (C5-C7)	1-3	Pentane, Hexane, Heptane
Ammonia	0.3	
Paraffin (C1-C4)	0	Methane, Ethane

NOTE: Relative sensitivity = meter reading when measuring 10 ppm of the listed gas with instrument with 10.2 eV probe calibrated for 10 ppm of benzene, span pot setting = 9.8 for direct reading of benzene.

APPENDIX A (Cont'd)

Tables

TABLE 3. Typical Applications of Interchangeable Probes

	Ionization Potentials	Relative Sensitivity	
p-Xylene	8.44	0.10	0.104
p-Chlorotoluene	8.70	0.09	0.112
Toluene	8.82	0.09	0.112
o-Chlorotoluene	8.83	0.075	0.112
Ethyl Acetate	9.19	0.075	0.112
Benzene	9.24	0.10	0.10
Methyl Mercaptan	9.24	0.10	0.072
Pyridine	9.32	0.075	0.122
Allyl Alcohol	9.67	0.10	0.111
Crotonaldehyde	9.88	0.075	0.104
Amyl Alcohol	9.80	0.09	0.116
Cyclohexane	9.88	0.075	0.104
Vinyl Chloride	9.95	0.085	0.112
Butanol	10.94	0.09	0.176
Ammonia	10.15	0.06	0.160
Acetic Acid	10.37	0.04	0.560
Ethylene	10.52	0.0	0.320
Ethylene Oxide	10.56	0.0	0.298

$$\text{Relative sensitivity} = \frac{\text{Response with 9.5 or 11.7 eV probe}}{\text{Response with 10.2 eV probe}}$$